Technology Readiness for Road Safety & Sustainability in Selected Eastern Partnership Countries

ARMENIA | GEORGIA | MOLDOVA

State Of the Art Review and Questionnaire Survey On Country-Level Technological Readiness

THIS REPORT IS FUNDED BY THE EUROPEAN UNION

WORLD BANK GROUP Transport

EaP | Eastern Partnership

ACKNOWLEDGEMENTS

This activity was funded by the European Union, through the Trust Fund “Strengthening Regional Transport Connectivity in the Eastern Partnership Region” and was carried out by a World Bank team formed by Elena Lungu (World Bank) , Eduardo Andres Espitia Echeverria (World Bank), Eleonora Papadimitriou (Assistant Professor of Mobility & Road Safety, National Technical University of Athens), William Wambulwa (Road Safety Consultant), Tatiana Mihailova (Road Safety Consultant).

We would like to thank Shomik Raj Mehndiratta (Practice Manager, World Bank Transport ECA team) for his support of this study. We also appreciate the contributions of Nora Mirzoyan (World Bank), Bhavin Bipinchandra Shah (Road Safety Consultant) for their review and client liaison support, as well as Iuliana Stratan for her administrative assistance.

We extend our gratitude to the following country stakeholders that have coordinated the country level data collection and public consultations on the final recommendations of the report: Arevik Poghosyan (Armenia), Poghos Shahinyan (Armenia), Nikoloz Gvenetadze (Georgia), Aleksandra Suladze (Georgia) and Pavel Apostol (Moldova). We also extend our gratitude to the Technical Secretariat of the Eastern Partnership Road Safety Observatory for their contributions and recommendations.

The World Bank team would like to thank its counterparts in Armenia, Georgia, and the Republic of Moldova for fruitful discussions, consultations, ideas, and access to data and information. This report was written in close consultation with the representatives of the Regional Working Groups as part of the EaP Transport Panel Secretariat Activity.

We acknowledge Francois Villard (DG ENEST) and Sarolta Csajbok (DG MOVE) for their participation and advice.

Table Of Contents

LIST OF FIGURES

List of Tables

List of Acronyms

Acronym	Full Form
(C)AV	(Connected and) Automated Vehicle
AADT	Annual Average Daily Traffic
ADAS	Advanced Driver Assistance Systems
AEB	Automated Emergency Braking
AI	Artificial Intelligence
AiRAP	Accelerated & Intelligent Road Assessment Programme
ALR	All Lane Running Motorway
AVC	Automated Vehicle Control
AVRI	Autonomous Vehicles Readiness Index
BEV	Battery Electric Vehicle
Cadas	Common Accident Data Set
CAGR	Compound Annual Growth Rate
CBA	Cost-Benefit Analysis
CCAM	Connected, Cooperative, and Automated Mobility
CCTV	Closed-Circuit television
CIO	Chief Information Officer
C-ITS	Cooperative Intelligent Transport Systems
CM	Controlled Motorway
CNN	Convolutional Neural Network
DARE	Digital Accessibility Rights Evaluation
DC	Direct Current
DHS	Dynamic Hard Shoulder Running Motorway
DUH	Environmental Action Germany/Deutsche Umwelthilfe
EaP	Eastern Partnership
ECOS	Environmental Coalition on Standards
EEB	European Environmental Bureau
ETSI	European Telecommunications Standards Institute
EU	European Union
EV	Electric Vehicles

Acronym	Full Form
EVP	Emergency Vehicle Preemption
FL	Federated (machine) Learning
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GII	Global Innovation Index
GPS	Global Positioning System
HEV	Hybrid Electric Vehicles
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
IEA	International Energy Agency
IoT	Internet of Things
iRAP	International Road Assessment Programme
IRR	Internal Rate of Return
ITF	International Transport Forum
ITS	Intelligent Transport System
ITSF	Intersection Traffic Safety Framework
I-VICS	Intelligent Vehicle Infrastructure Cooperation System
JRC	Joint Research Centre
KPI	Key Performance Indicators
LIDAR	Light Detection and Ranging
LMICs	Low- and Middle-Income Countries
MHYD	Manage-How-You-Drive
ML	Machine Learning
MPD	Miles per Disengagement
MPO	Metro Planning Organization
NAP	National Access Point
NHTSA	National Highway Traffic Safety Administration (US)
NPV	Net-Present Value
NRI	Network Readiness Index
ODD	Operational Design Domain

Acronym	Full Form
OEM	Original Equipment Manufacturer
PAYD	Pay-As-You-Drive
PCRA	Predictive Collision Risk Area
PHEV	Plug-in Hybrid Electric Vehicle
PHYD	Pay-How-You-Drive
RCC	Regional Control Centre
RSU	Roadside Unit
RTTI	Real-Time Traffic Information
SAE	Society of Automotive Engineers
SM	Smart Motorway
SPS	Signal Priority Strategy
SRTI	Safety-Related Traffic Information
TAM	Technology Acceptance Model
TCO	Total Cost of Ownership
T-EHM	Telematics-Based Equipment Health-Monitoring
TRAM	Technology Readiness and Acceptance Model
TRI	Technology Readiness Index
TRL	Technology Readiness Levels
TTC	Time-To-Collision
UBI	Usage-Based Insurance
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VRU	Vulnerable Road User
WHO	World Health Organization

EXECUTIVE SUMMARY

Road traffic crashes are responsible for 1.19 million fatalities globally (WHO, 2023), constituting a persistent global epidemic across motorized societies. Fatality rates in the Eastern Partnership (EaP) countries[1] significantly exceed the European Union-27 average of 4.5 deaths per 100,000 population recorded in 2021, and the cost of road fatalities and serious injuries is around 4.5% of GDP across the five Eastern Partnership countries, much higher than the EU average of 2%. In order to mitigate the occurrence and severity of crashes, in line with the Vision Zero strategy of the European Commission, several technological advancements have been devised or are in high stages of maturity. **As part of road safety cooperation between EaP countries**, their collaboration and exchange of knowledge on the latest road safety technologies and their deployment in the region, has the potential to bring new insights for the pertinent policies that can accelerate technology adoption in their countries, and a new opportunity for achieving their road safety & sustainability targets.

This report explores the **technological readiness of Eastern Partnership (EaP) countries to adopt emerging road safety and sustainability technologies**, such as: (i) Connected and Automated Vehicles (CAVs) and Advanced Driver Assistance Systems (ADAS), (ii) Electric Vehicles (EVs), (iii) AI-based safety tools and (iv) Driver Telematics. While these technologies are increasingly deployed in high-income countries, their implementation in low- and middle-income countries (LMICs), particularly in the EaP region, faces multiple barriers including infrastructural limitations, outdated vehicle fleets, and a lack of institutional and societal preparedness. Recognizing the need for context-specific strategies, the study aims to bridge this gap by examining the current state of technology adoption and identifying critical enablers and obstacles.

The report proposes **a comprehensive methodology to assess technological readiness, focusing on the selection of appropriate Key Performance Indicators (KPIs) relevant to the countries**. A stakeholder-informed approach is employed, including the development of a dedicated questionnaire targeting transport and road safety actors in the EaP region. The results are expected to guide policymakers in designing tailored, data-driven strategies that enhance technological capacity, foster sustainability, and improve road safety outcomes in the region.

Initially, a holistic examination of the **current state-of-the art** is provided for the four aforementioned pillars:

(i) **Connected and Automated Vehicles (CAVs)** are reshaping transportation by combining AI with vehicle-to-everything (V2X) communication, enabling vehicles to perform driving tasks without human input. While progress in regions like the EU, US, and China is accelerating—especially with Level 1–3 automation—emerging economies face barriers such as poor infrastructure and limited institutional capacity. CAVs promise significant improvements in road safety by reducing human errors, which are contributory factors for a majority of traffic crashes. However, new risks emerge, such as system malfunctions, cybersecurity threats, and the potential for passengers relying too heavily on automation. Pedestrians and cyclists may also face increased risks if CAVs do not communicate effectively with vulnerable road users. As CAV technology evolves, ensuring robust safety features, effective regulations, and public awareness is essential.

(ii) **EVs (BEVs, PHEVs, HEVs)** offer an eco-friendly alternative to combustion engines, reducing CO_2 and air pollution. With transport accounting for ~24% of global CO_2 emissions, electrification is key for

[1] Armenia, Azerbaijan, Georgia, Moldova and Ukraine

decarbonization. EV adoption is growing in public transit, logistics, and light vehicles. The EU saw EV market share rise to 15.5% in 2024. EVs often feature advanced driver-assistance systems (ADAS), regenerative braking, and low centers of gravity, which enhance stability and reduce rollover risks. However, their quiet operation at low speeds poses a risk to pedestrians, especially those with visual impairments, prompting regulations for artificial sound generators. Battery weight may increase crash severity, and battery integrity is crucial, as thermal runaway, though rare, can cause fires. Proper infrastructure and regulation will ensure EVs contribute positively to road safety.

(iii) **AI-driven technologies** are revolutionizing road safety across transport systems, allowing for faster, more accurate decision-making and predictive analytics. With Big Data, AI, and real-time monitoring systems, road safety professionals can better identify and mitigate risks by analyzing vast datasets from connected vehicles, sensors, and traffic infrastructure. These innovations support targeted interventions, such as optimizing traffic flow, predicting potential collisions, and enhancing emergency response times. However, challenges such as data privacy concerns, system reliability, infrastructure costs, and the need for high-speed connectivity still present significant hurdles for the full-scale deployment of these technologies.

(iv) **Driver Telematics** utilize real-time driving data to personalize driving behaviour assessment, moving away from static assessments based on demographic or vehicle-related factors. Telematics systems offer GPS tracking, engine diagnostics, accelerometers, and connectivity modules, enabling applications like personalized insurance schemes (e.g. “pay-as-you-drive”), fleet management and equipment health monitoring. Telematics have demonstrated a significant positive impact on road safety by enabling more accurate risk assessments and promoting safer driving behavior through feedback mechanisms. Despite these benefits, telematics adoption faces challenges in data privacy, sensor optimization, and technological scalability.

Subsequently, a presentation of various technological readiness indices and KPIs is provided. When considering **technological readiness at the country level**, a complex interplay of factors is involved, including access to innovation, economic stability, education, cultural attitudes, infrastructure, and government policy. Countries that foster innovation through supportive governance, targeted investments, and inclusive digital strategies tend to integrate emerging technologies more successfully. Cultural openness to change, digital literacy, and workforce adaptability also play key roles, while challenges such as data privacy, cost barriers, and resistance to new methods can hinder progress. Within a **transport context, technological readiness** is evaluated in the scientific and professional literature through various KPIs tailored to the specific innovations mentioned above.

The **developed questionnaire** comprised the following sections: (i) General Technology Readiness; (ii) Vehicle Safety & Automation; (iii) Electric Vehicles & Sustainability; (iv) Big Data, Digitalization & AI Applications; (v) Key road safety figures; (vi) Country experiences with advanced road safety and sustainability technologies; and (vi) Technology acceptance & trust by country stakeholders. The country responses received are summarized as follows:

Armenia has a national strategy for technology adoption and digital transformation. The government has adopted several strategic documents, including the “Digital Transformation Strategy 2021–2025”[2] and the

[2] Armenia’s Digital Transformation Strategy (2021-2025): https://dig.watch/resource/armenias-digital-transformation-strategy-2021-2025
https://www.primeminister.am/en/press-release/item/2020/07/20/Nikol-Pashinyan-meeting-Digitization/

"Armenia Digital Agenda – 2030," which set clear objectives for enhancing digital infrastructure, digital governance, public service transformation, and fostering innovation across the economy. Armenia has a data protection law and is updating its legal framework for electronic communications to align with EU standards. Armenia's national strategies include increasing public investment in the road system to 1% of GDP by 2025 and reducing road accidents caused by road malfunctions by up to 20% by 2026. Key transport technology developments in the country are:

- The Ministry of Territorial Administration and Infrastructure (MTAI), Ministry of Internal Affairs, and other agencies have adopted data analytics platforms for real-time road crash and black spot analysis.
- As of 2025, the CSIE Foundation is actively conducting research and development in advanced navigation and control systems for autonomous vehicles, with the aim of building an Autonomy Centre of Excellence.
- The "Re-framing Road Safety in Armenia" project is a key example of multi-stakeholder collaboration. This initiative integrates data analytics, behavioral science, and policymaking to improve road safety, with a strong partnership between government, international organizations, and private expertise.
- Armenia has a well-developed and evolving framework for data standards and governance in the public sector, combining legal, technical, and institutional measures to promote secure, interoperable, and transparent data management.
- Armenia has traffic management centers for both main urban and interurban roads. The Technology Management Center of Yerevan City oversees urban traffic, including adaptive signal systems.
- Armenia has a robust system of speed and traffic cameras, supported by a penalty point and fine-based enforcement regime for key violations such as speeding and mobile phone use while driving. Fleet operators and some private users can access advanced telematics and GPS-based monitoring, with feedback provided via apps and dashboards.

Main challenges for transport technology adoption in the country include:

- The Armenian vehicle market primarily imports vehicles from countries like the UAE, the US, and China, where ADAS adoption is growing but not uniformly mandated for all new vehicles.
- Armenia does not have a dedicated, comprehensive national strategy or action plan specifically for the deployment of electric vehicles (EVs).
- Armenia currently possesses high-resolution topographic and satellite maps suitable for general navigation, urban planning, and GIS applications, but these do not meet the stringent requirements of HD maps for AVs (centimeter-level accuracy, semantic layers, real-time updates).

Georgia recognizes digitalization as a strategic priority—investing in connectivity, reforming public services, establishing coordinating bodies, and working toward advanced tech policies like AI and blockchain. The country has several formal national-level strategies and initiatives centered around digital transformation and technology adoption. Georgia is actively investing in transport and road safety technologies through a mix of national strategies and international support. The 2023–2030 National Transport and Logistics Strategy and its 2023–2024 Action Plan prioritize safety standards, digital systems, and EU regulatory alignment. The country has received significant support in road infrastructure upgrade projects and road safety databases. Key transport technology developments in the country are:

- The Georgian Roads Department (GRD) has initiated the deployment of V2I systems to enhance road safety and traffic management. This includes the installation of roadside units (RSUs) at key intersections to enable communication between vehicles and traffic infrastructure.
- In 2018, the Georgian government launched the “Green Policy – Eco-friendly Transport” project, aiming to replace 90% of the national vehicle fleet with electric cars within the next decade; a number of incentives are in place to meet this goal. The number of newly registered EVs increased 5 times between 2018-2023, rising from 2.4% of newly registered passenger cars in 2018, to 9.3% in 2023.
- EU- General data Protection Regulation (GDPR) is adopted in the country.
- There is a traffic management center in Tbilisi. For the moment it supervises and monitors traffic through closed-circuit television (CCTV) cameras and supervises traffic light operations. There is an ongoing project to expand operational capacity of the center and staff to accommodate all services/tools for provision/utilization of services.
- Georgia has equipped several cities with smart cameras capable of detecting various traffic violations, including speeding, red light running, and unauthorized lane usage. These cameras are supported by analytical software with capabilities such as automatic license plate recognition. The footage captured is connected to a unified video surveillance system, enabling 24/7 real-time monitoring and enforcement.

Main challenges for transport technology adoption in the country include:

- Georgia does not have a dedicated national strategy or action plan specifically addressing the deployment of automated vehicles.
- Real-time traffic information for drivers is limited. Some urban areas have basic traffic cameras, but widespread, dynamic variable message signs (VMS) or mobile apps providing live traffic updates are not yet commonly deployed at scale.

Moldova has a Digital Transformation Strategy for 2023-2030, adopted on 6 September 2023, as the framework guiding the country’s digital future. In late 2024 and early 2025, the government issued a White Paper on AI and Data Governance, aligning national AI strategy with EU frameworks. Moldova is actively supported by international programs to implement large-scale road reconstruction, upgrade key corridors to European safety norms, and prepare for smart transport systems through ITS frameworks and EU-aligned technical specifications. Main road safety technology developments are as follows:

- Chișinău's Traffic Monitoring Centre (TMC) was launched in November 2024, integrating ~180 traffic cameras, road sensors, public transit data, parking monitors, and radars to offer live traffic data for optimizing signal timings, reducing delays, and enhancing safety. The system provides real-time information for both public transport users (e.g., trolleybus arrival times seen at stops) and general drivers.
- The National Road Administration deployed a centralized platform integrating road traffic counters and weather data
- Moldova has introduced several policies and incentives aimed at accelerating the adoption of electric vehicles (EVs), focusing on environmental sustainability, economic benefits, and energy efficiency

- There are private services available providing drivers with real-time traffic information or urban travel support.
- Main challenges for transport technology adoption in the country include:
- 5G rollout is underway since 2024;
- Moldova shows a less dynamic development in the deployment of EVs compared to its neighboring countries.

The review of the state of the art and the questionnaire survey carried out within this study revealed that **the level of knowledge of ITS and the awareness of their importance in road safety improvements are very high in the EaP region**. However, **their actual readiness to deploy these technologies and systems, and benefit from them in the short-to-medium-term, are moderate to limited**. International technology readiness rankings show that the EaP countries perform relatively well among middle and lower-middle income nations, reflecting progress but ongoing challenges in innovation, capacity, and human capital.

When **benchmarking the selected EaP countries** on the basis of an adapted technology readiness scale (CRS – country readiness scale ranging from CRS 1 – Awareness to CRS 6 – Mature Ecosystem), the following conclusions can be drawn:

- **On CAV deployment**, Armenia is at CRS 1 – Awareness, while Georgia and Moldova are at CRS 2 – Emerging Testing
- **On EV deployment**, Armenia and Moldova are at CRS 2 – Emerging, while Georgia is at CRS 3 – Early Expansion
- **On Big Data & AI applications**, Georgia is at CRS 2, while Armenia and Moldova are at CRS 3.
- **On driver telematics**, Armenia and Moldova are at CRS 3, while Georgia is at CRS 4 – Scaling integration.

On the other hand, most of the EaP countries show commitment and potential in governance and institution relevant to technology deployment. Moreover, **the majority of the countries still place emphasis on the upgrade of their physical transport infrastructure**, e.g. the further development and improvement of their road networks.

Therefore, it is concluded that **road safety technology should be gradually integrated in the medium-term, with the following areas of priority**:

(a) **Vehicle standards**: EaP countries should adopt the core UN Vehicle Regulations as regards safety features, technical inspections etc. In the medium-to long-term, it is recommended that they harmonize their vehicle safety and CAV regulations with advanced frameworks like the EU Vehicle Safety Regulation (EU) 2019/2144 or UNECE WP.29 AV rules, creating a regulatory background for CAV deployment.

(b) **Connectivity**: EaP countries should accelerate 5G deployment, which is crucial for many transport innovations. Particular care should be given to digital infrastructures and networks coverage in rural areas, where critical road safety issues exist.

(c) **Energy efficiency**: countries should take steps to minimize energy dependency and develop resilient networks, in order to accommodate future transport technologies.

(d) **Data Privacy, Cybersecurity, and Liability Issues**: While emerging regulations emphasize data systems safety, cybersecurity, and data governance / management, there is little experience with implementing such formal guidelines to address specific technology-related concerns, such as road user privacy, unauthorized access etc.

(e) **Road and transport infrastructure**: EaP countries should include future outlook for digital infrastructures and machine-readable road equipment in their current network development and upgrade projects. In urban areas, particular focus should be put on inclusive designs that will allow for technological solutions to cover **pedestrians, cyclists, micromobility users** etc. Moreover, integration with other sectoral technologies, e.g. energy grids, urban logistics,

(f) **Human capital**: Countries should invest in professional education in the fields of data science, digitalization, ICT and their management (including security risks), in order to ensure knowledge and capacity at the medium / operational level of government, institutions and industry. At the same time, investment in engineering and technology management education will provide a new generation of professionals that may accelerate adoption and acceptance of innovation in national transport projects, as well as lead their implementation.

It is to be underlined that, while new technologies bring important potential for further road safety improvements, **they should not be perceived as a panacea for road safety problems**. There are several road safety challenges that can be effectively addressed by means of infrastructure design (including VRU inclusive design) and speed enforcement. Countries should **prioritize basic Safe System interventions** and gradually integrate road safety technologies.

Several countries in the region face financial and political challenges and rely heavily on external funding and public-private partnerships to advance smart mobility initiatives. However, there are **opportunities for future-proof projects to be developed already from the design stage**, and flexible collaborative funding schemes may accelerate project implementation. Finally, **a roadmap with concrete steps to increase technology readiness** in the short-, medium- and long-term is presented as a guide for future actions.

CHAPTER 1. INTRODUCTION

1.1. GENERAL PROBLEM FORMULATION

Around the globe, road safety continues to be a **major global health and sustainability challenge**. Road traffic crashes are responsible for 1.19 million fatalities globally[3]. The number of traffic fatalities has somewhat declined compared to previous years (e.g., 1.35 million in 2018); however, road crashes remain the leading cause of death among individuals under 29 and are still among the top 10 causes of death globally. The United Nations Sustainable Development Goal (UNSDG) Target 3.6 seeks to halve road traffic deaths by 2030—a target adopted by most countries worldwide. Additionally, the European Commission has embraced the Vision Zero strategy[4], a road safety paradigm aiming to eliminate fatalities across the region by 2050[5]. Vision Zero recognizes that humans are fallible and thus shifts the responsibility for road safety from individual road users to the entire transport system, emphasizing that road designers, policymakers, vehicle manufacturers, and law enforcement all share responsibility for preventing fatalities and serious injuries.

One mechanism that is key to promote Vision Zero is the Safe System Approach[6]. This approach has been established on the belief that all road crashes are preventable and stem from failures within a complex system that requires coordinated and systemic solutions. Therefore, all road crash fatalities should be eliminated as preventable events. The Safe System Approach acknowledges the many factors involved in crashes, including vehicle and infrastructure safety, environmental conditions, and human behavior. It underpins the Global Plan for the UN Decade of Action for Road Safety 2021–2030, which promotes a wide range of interventions such as integrated land-use and transport planning, community engagement, robust engineering standards, regulated vehicle safety, effective enforcement and education, and well-coordinated post-crash response systems. The plan emphasizes that road safety is a shared responsibility, requiring collaboration across governments, the private sector, civil society, and local communities to achieve meaningful reductions in road traffic fatalities.

In response to the dire road safety issues worldwide, **technology developments are fast emerging, aiming to essentially improve road safety and accelerate traffic fatality reductions** – which are stagnating in many countries. These technologies and tools concern (but are not limited to) Advanced Driver Assistance Systems (ADAS), Connected and Automated Vehicles (CAVs), Electric Vehicles (EVs), Big Data collected from various sensors, AI applications for proactive road safety management, driver telematics for monitoring driver behaviour, etc. However, it has been highlighted that these technologies and applications are mostly developed in and adopted by industrialised countries, while their potential for effective deployment in LMICs is not taken into account.

LMICs may have a lower technology readiness level, due **to institutional, technical, or societal barriers**. For instance, digital and physical infrastructures may be inadequate to accommodate last generation ADAS or EVs; vehicle fleets may be aged and lacking core safety features or environmental standards; road crash data collection and handling may be done in paper form; the use of traffic monitoring cameras may be sporadic, etc.

[3] WHO (2023). Global status report on road safety 2023. Available: https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/global-status-report-on-road-safety-2023
[4] Johansson R. (2009). Vision Zero - Implementing a policy for traffic safety, Safety Science, 47(6). doi:10.1016/j.ssci.2008.10.023.
[5] European Union (2019). EU Road Safety Policy Framework 2021-2030 – Next Steps towards "Vision Zero".
[6] U.S. Department of Transportation. What is a Safe System Approach: https://www.transportation.gov/safe-system-approach

More specifically, in an increasingly digitalized and interconnected transport system, technological readiness plays a pivotal role in shaping a country's economic growth, innovation capacity, and global competitiveness. As nations strive to integrate emerging technologies such as artificial intelligence (AI), partial or full vehicular automation, and advanced telecommunications, assessing their level of preparedness becomes crucial for policymakers, investors, and international organizations. However, **evaluating technological readiness at the country level** is a complex challenge, requiring a multidimensional framework that accounts for infrastructure, human capital, regulatory environment, and digital adoption.

Key Performance Indicators (KPIs) serve as essential quantities for measuring and benchmarking technological readiness across countries in general, and transport technology in particular. These indicators help identify strengths, weaknesses, and areas requiring policy intervention. However, selecting the most relevant KPIs poses significant challenges due to variations in data availability, economic structures, and national priorities. Moreover, the consultation of national and local stakeholders with respect to the needs, barriers and opportunities on technology adoption, can provide valuable insights into the regulatory, technical and operational steps that need to be taken to accelerate technology benefits.

As part of road safety cooperation between EaP countries, their collaboration and exchange of knowledge on the latest road safety and eco-driving technologies and their deployment in the region, has the potential to bring new insights for the pertinent policies that can accelerate technology adoption in their countries, and a new opportunity for achieving their road safety & sustainability targets.

Based on this backdrop, **this report aims to systematically assess the road safety related technological readiness of Eastern Partnership (EaP) countries** through a scientifically grounded methodology. Particularly, it seeks to:

- Assess technological readiness at the national level, providing an evaluation of each country's position and its potential areas of opportunities and challenges.
- Conduct a comparative analysis of EaP countries' technology readiness, utilizing a dedicated assessment framework tailored to their context, yet in line with international good practice.
- Identify key challenges related to policy and regulation, information and communication technology (ICT) infrastructure, drawing on insights from global best practices.
- Facilitate the exchange of knowledge and good practices at regional level, to support the advancement of technological readiness in EaP countries.

A dedicated questionnaire has been developed and addressed to the EaP stakeholders to inform this analysis. This study has the following objectives:

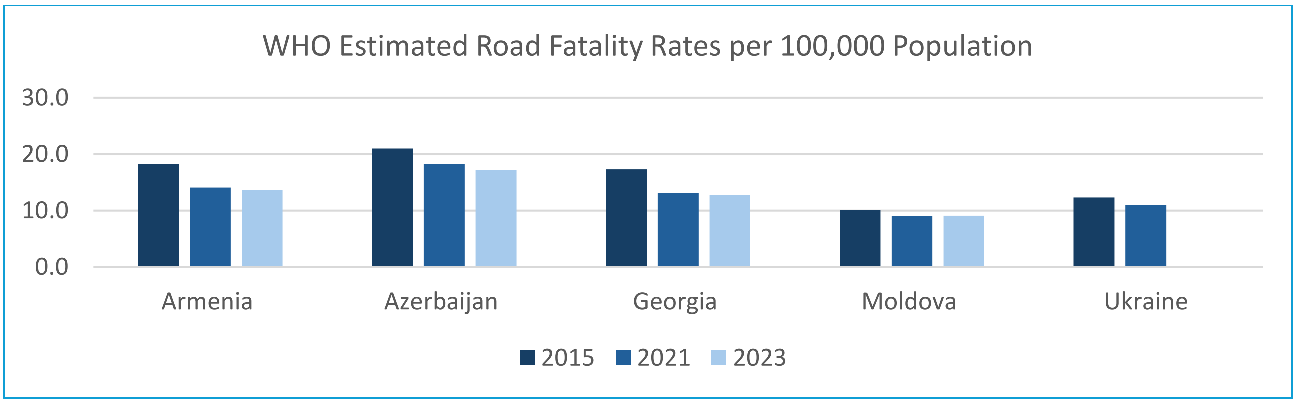
- **to review the state-of-the-art on road safety and sustainability technologies** with potential of substantially improving the burden of traffic casualties and environmental externalities of transport systems, by reviewing technology deployment in the European Union (EU) context, good practice experiences from European countries.

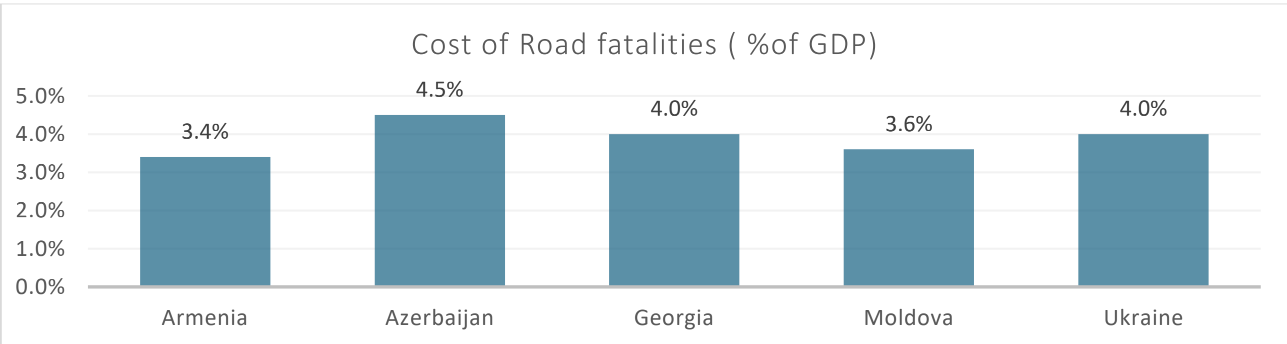
- **to review existing technological readiness assessment frameworks and develop a structured methodology for selecting the most relevant KPIs** in the transport sector, and more specifically in the road safety sector.
- **to develop a survey questionnaire aimed at transport / road safety stakeholders** in the EaP region, to gather information on road safety and sustainability technologies in the respective countries.
- to **assess and benchmark the Technology Readiness of the EaP countries** based on the collected information.
- to **identify key challenges on road safety technology readiness** in the EaP countries.
- to propose **recommendations** for countries to improve their technology readiness, as well as a road map with concrete actions for the short-, medium- and long-term.

1.2. ROAD SAFETY IN THE EASTERN PARTNERSHIP

EaP countries have significant room to improve road safety performance. Fatality rates in several EaP countries significantly exceed the European Union-27 average of 4.5 deaths per 100,000 population recorded in 2021. Road traffic deaths and injuries remain a significant issue across all EaP countries, highlighting the need for urgent and coordinated action. On average, the cost of road fatalities and serious injuries is around 4.5% of GDP across the five Eastern Partnership countries, much higher than the EU average of 2%[3,7]. Figure 1.1 below shows the fatality rates and estimated costs for EaP countries.

Figure 1.1: Road Fatality Rates and Estimated Costs in EaP Countries





Source: EaP RSO, 2024

[7] Eastern Partnership Road Safety Observatory. Annual Report 2024. Available: https://eaprso.org/data-and-knowledge/annual-report-2024/

A 2022 World Bank review revealed significant gaps in road crash data systems across Eastern Partnership (EaP) countries. Key issues included the absence of formal crash databases (except in Azerbaijan), lack of open data practices, and incomplete adoption of the mini-CADaS protocol, with Moldova collecting the fewest variables and Georgia the most. Since then, countries have made progress, submitting data protocols and raw datasets to the Eastern Partnership Road Safety Observatory (EaP RSO), though these remain incomplete and require harmonization. Common challenges include aligning hospital and police data, adopting MAIS standards for injury classification, and systematically gathering behavioural risk data—only Armenia has taken part in an ESRA survey to this end.

1.2.1. NATIONAL ROAD SAFETY EFFORTS

1.2.1.1. Armenia

In 2019, Armenia revised its crash data collection form to better align with the EU's CADaS protocol. The new National Road Safety Program (2023–2027), emphasizes the adoption of Vision Zero and the Safe System Approach. Although not yet formally adopted, the government continues upgrading its data management systems to enhance data quality, analysis, and decision-making, with strong cross-agency commitment to improving road safety outcomes. A real-time hot spot data analytics platform has been launched containing data from over 23,000 road crashes.

1.2.1.2. Azerbaijan

Azerbaijan's 2019–2023 State Program on Road Safety prioritized a systematic approach to improve road user behavior, road culture, and traffic safety. Central to this strategy is the collection and analysis of accurate road safety data to inform preventive measures and monitor their impact. In December 2024, the State Road Police hosted a High-Level Meeting on Road Policing with WHO, showcasing progress and exploring best practices to further support these objectives. As host of COP29, Azerbaijan supported the MAP Declaration, advocating for low- and zero-emission, integrated transport systems with safe access to active mobility. The Ministry of Transport is leading efforts to unify stakeholder data into a single electronic-analytical road safety database, with particular attention to pedestrian safety.

1.2.1.3. Georgia

Georgia's 2022–2025 National Road Safety Strategy, adopted in November 2023, emphasizes Vision Zero, the Safe System Approach, and shared stakeholder responsibility. To support this, a dedicated road crash data unit was established within the Ministry of Economy and Sustainable Development, while the Ministry of Internal Affairs introduced a unified database for crash reporting. Georgia is actively working to align its data practices with the EU's CADaS standards. Pedestrian safety has been prioritized through the introduction of 30km/h school zone speed limits in Tbilisi and other Georgian cities, along with new pedestrian-safe infrastructure, reducing road casualties in these areas.

1.2.1.4. Moldova

Moldova endorsed a new National Road Safety Program in 2025, anchored in the Safe System Approach and backed by a detailed action plan through 2030. The strategy highlights participation in the EaP RSO and the need to enhance road safety data quality. Moldova is currently upgrading its crash data system with the goal of meeting CADaS standards. The National Road Traffic Regulations were recently amended to mandate 30 km/h speed limit zones in areas with high pedestrian activity, including streets near schools, historic city centers, parks, and other public spaces where vulnerable road users interact with traffic.

1.2.1.5. Ukraine

Despite the disruptions caused by the Russian invasion, Ukraine remains committed to reducing road crash impacts. The government is developing a new crash data system to support urban safety initiatives, focusing on identifying high-risk locations (hotspots) and improving safety for vulnerable road users. Data integration and sharing are key to these efforts. For more than a decade, the State Emergency Service of Ukraine (SESU) has focused on enhancing post-crash emergency response through improved coordination and training. Their efforts emphasize joint strategic planning and reporting among police, ambulance, and fire services to strengthen the overall effectiveness of crash response.

1.2.2. THE EASTERN PARTNERSHIP ROAD SAFETY OBSERVATORY

The European Union and its member states, along with Eastern Partnership countries, share a commitment to reducing road deaths to near zero by 2050. Following official commitments in the Eastern Partnership Declaration on Road Safety of 2018 by the governments of the Republic of Armenia, Republic of Azerbaijan, Georgia, Republic of Moldova and Ukraine, this vision was formalized in a 2019 Joint Declaration. This led to the establishment of the Eastern Partnership Road Safety Observatory (EaP RSO). Officially launched in February 2024[8] and hosted in Georgia, the EaP RSO aims to strengthen and harmonize road crash data to support effective safety policies across the region. Despite challenges such as the pandemic and regional conflicts, the Observatory has already made progress, including launching a website, fostering data-sharing, and engaging national stakeholders. All these actions demonstrate its early potential to improve road safety and support member countries to enhance road safety policy making and crash data analysis.

Since its launch in February 2024, the Eastern Partnership Road Safety Observatory (EaP RSO) has focused on building the foundations for regional cooperation in road safety. This includes securing Memorandums of Understanding with Armenia, Georgia, Moldova, and Ukraine for data-sharing, identifying national training and technical assistance priorities, and engaging in around thirty structured meetings with stakeholders. These sessions have covered a wide range of topics such as onboarding, technical data management, communications strategy, capacity building, and high-level engagement. The Secretariat also established a Communications Working Group and launched a comprehensive website, designed to serve both as a public information hub and a secure platform for member states to exchange data, resources, and expertise.

The EaP RSO (https://eaprso.org/) platform is an online freely available and open knowledge hub.

As per the aforementioned, inconsistencies in data locations, incomplete CADaS compliance, limited capacity in police crash investigations, and underuse of crash data for local risk management remain constant challenges. The lack of digital tools and discrepancies between national fatality data and WHO estimates further complicate the picture. To address these issues, the EaP RSO is focusing on training, technical assistance, and peer learning initiatives to improve data quality, comparability, and the overall effectiveness of road safety strategies in the region.

---

[8] EASST: Work starts on the Eastern Partnership Road Safety Observatory. Available: https://www.easst.co.uk/work-starts-on-the-eastern-partnership-road-safety-observatory/

A key goal of the EaP RSO is to harmonise crash data collection and analysis across its member countries to improve evidence-based policymaking. Despite delays in acquiring raw data due to differing national systems and challenges, efforts are ongoing to facilitate data exchange and improve quality. The member-only portal of the website will provide tools for comparative analysis, secure document sharing, training materials, and direct communication with experts.

1.3. KNOWLEDGE GAPS

Despite the growing importance of road safety & sustainability technological readiness, existing assessment frameworks face several limitations that hinder accurate cross-country comparisons. One major challenge is the lack of a standardized KPI selection framework, as different studies rely on varying indicators, making it difficult to establish consistent benchmarks. Additionally, many assessments suffer from variability in data availability and quality, often relying on self-reported or incomplete datasets, which undermines the reliability of technological readiness evaluations. Another limitation is the insufficient consideration of emerging technologies, as most current frameworks focus primarily on traditional digital infrastructure (such as 5G internet penetration) but fail to incorporate newer technological advancements in fields such as cybersecurity. Addressing these gaps requires a systematic and adaptable KPI selection methodology that ensures reliable, context-aware, and policy-relevant assessments of technological readiness.

Specifically for the Eastern Partnership (EaP) countries, these gaps are even more pronounced due to additional regional complexities. EaP countries often face unique infrastructure limitations, fragmented regulatory environments, varying levels of public trust in new technologies, and resource constraints that significantly differ from Western European contexts. As a result, technological readiness assessments that do not explicitly accommodate these regional factors may yield limited or misleading insights, undermining the effectiveness of policy interventions.

Ultimately, addressing the identified gaps with region-specific considerations will enable more accurate assessments and more effectively tailored interventions, leading to accelerated adoption and optimized benefits of road safety and sustainability technologies in EaP countries.

1.4. REPORT OUTLINE

After this Introduction, the present report is structured as per the following: in **Chapter 2**, an overview of the relevant literature is outlined regarding the key emerging technologies related to road safety and sustainability, grouped under four main areas:

- Connected and automated vehicles,
- Electric vehicles,
- Big Data and AI applications,
- Driver telematics.

In each case, good practice examples in the European context are presented, together with an overview of the main characteristics, expected benefits and deployment challenges.

Chapter 3 starts with a presentation of the findings of the review of the various overarching factors affecting technological readiness in general. Afterwards, a summary of three widespread KPI-oriented indices is showcased, in order to position the present report within the international practice. Specific KPIs within the transport, road safety and sustainability context are then described.

Based on this body of knowledge, **Chapter 4** presents the dedicated Stakeholder Questionnaire, which was designed to specifically assess the technology readiness of the EaP countries with respect to road safety and sustainability technologies. Subsequently, the country profiles of three responding countries are presented in detail: Armenia, Georgia and Moldova. Their questionnaire responses were complemented with additional reviews of scientific and professional literature, as well as publicly available resources and open data. All additions were validated by the countries.

Chapter 5 presents a comparative assessment of transport/ road safety technology readiness in the selected EaP countries. Starting with an assessment of their road safety performance, the chapter summarizes the country's benchmarks on available technology readiness indices. Subsequently, a comprehensive overview of existing vehicle standards, infrastructure state and transport / road safety technologies currently in place is carried out. From these, a number of good practice examples from the EaP region are drawn, as well as a number of institutional, regulatory and technical challenges for further innovation in the field.

Finally, **Chapter 6** presents a benchmark of the EaP countries against EU good practice, and the recommendations of this study on the next steps, including a road map for short-, medium- and long-term technology progression.

CHAPTER 2. STATE OF THE ART ON ROAD SAFETY & SUSTAINABILITY TECHNOLOGIES

The present chapter outlines the present edge of technological progress across the most crucial pillars of emerging technologies in the field of transport and road safety. These pillars concern developments in:

- Connected and Automated Vehicles (CAVs),
- Electric Vehicles (EVs),
- Big Data and Artificial Intelligence (AI) applications, and
- Driver and fleet telematics

For each pillar, an initial provision of relevant terminologies is followed by examples of current deployment, primarily focusing on the EU, as well as the outline of any measured and anticipated road safety and environmental impacts, culminating with a discussion of related challenges and potential limitations.

2.1. CONNECTED AND AUTOMATED VEHICLES

Autonomous or Automated Vehicles (AVs) vehicles are equipped with computer pilots, leveraging Artificial Intelligence to navigate road networks with processes that replace the need for a human driver (various definitions exist in relevant literature[9]). These vehicles rely on a combination of sensors and auxiliary devices to gather real-time data about their surroundings. This data is then processed by algorithms that handle all driving functions, including control and decision-making, traditionally performed by human drivers. In addition to their native analysis, AVs achieve this through communication with other vehicles (V2V) and infrastructure elements (V2I), collectively referred to as vehicle-to-everything (V2X) communication.

In recent years, **Connected and Autonomous Vehicles (CAVs)** and related technologies have been the focus of extensive research and development. There is widespread anticipation regarding the benefits of automation and its potential to transform the transportation sector, with some optimistic projections expecting its realization in the near future. However, as an emerging technology, its full impact on various aspects remains uncertain (ERSO, 2018).

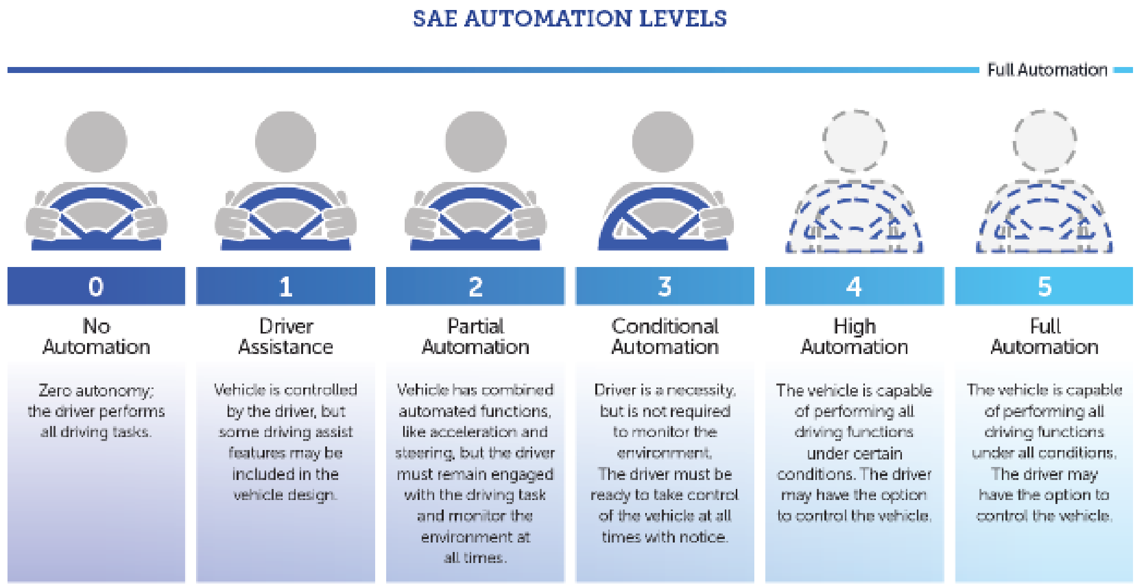
Additionally, while optimism about the transformative impacts of CAV technologies prevails in EU, US, and China, other regions—including emerging economies and the EaP countries face significant barriers due to less developed digital infrastructure, economic constraints, and limited institutional capacity. Thus, expectations for near-term impacts from CAVs in these regions must be moderated and contextualized accordingly.

2.1.1. AUTOMATION LEVELS

Automation levels, particularly in autonomous vehicles, are classified by the SAE (Society of Automotive Engineers) J3016 standard. **These levels range from Level 0 (no automation) to Level 5 (full automation)**, defining the degree of control and decision-making managed by the vehicle versus the human driver.

[9] Zmud, J., Sener, I. N., & Wagner, J. (2016). Consumer acceptance and travel behavior: impacts of automated vehicles (No. PRC 15-49 F). Texas A&M Transportation Institute

Figure 2.1: Automation Level Phasing



Source: NHTSA, 2017

Figure 2.2: Overview of Automation Levels

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Source: SAE, 2016

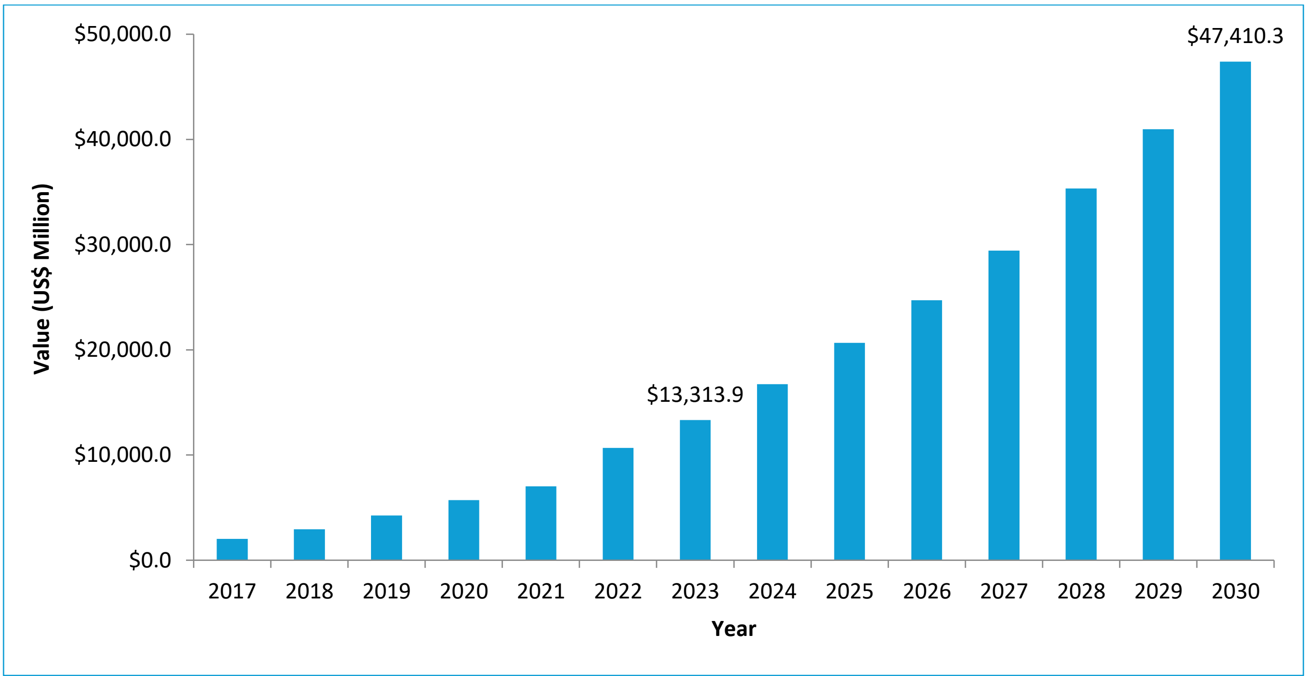
In simple terms, at Level 0, the driver controls all aspects of driving, though some assistance features like warnings or emergency braking may exist. Level 1 introduces basic driver assistance, such as adaptive cruise control or lane-keeping, but the driver remains fully responsible. Level 2 enables the vehicle to manage both steering and acceleration/braking simultaneously, though constant human supervision is required. Level 3 allows the vehicle to operate autonomously under specific conditions (or Operational Design Domains - ODDs), but the driver must be ready to take control if needed. Level 4 enables full automation in designated areas without human intervention, though manual operation may be required outside those zones. Finally, Level 5 represents complete autonomy, where the vehicle can handle all driving tasks in any environment, eliminating the need for a human driver.

Notably, while higher levels of automation (Levels 4 and 5) are being actively pursued in technologically advanced regions, such as the EU and North America, regions with limited infrastructural support—particularly the EaP countries—are currently more realistically positioned to adopt and benefit from lower automation levels (Levels 1–2), which require less extensive digital infrastructure upgrades and fewer regulatory adaptations.

2.1.2. CAV FIGURES WITHIN AN EU CONTEXT

As of 2023, the **European (C)AV market** was valued at approximately USD 13.3 billion and is projected to grow at a compound annual growth rate (CAGR) of 19.9% from 2024 to 2030. The heavy-duty (C)AV vehicle segment in Europe (excluding the U.K.) was valued at $39.6 billion in 2023 and is anticipated to reach $387.2 billion by 2032, reflecting a CAGR of 28.82% during the forecast period, also shown in Figure 2.3[10].

Figure 2.3: Past and Projected Growth of the AV Market within Europe, 2017-2030 (US$M)



Source: Horizon, 2025[10]

While specific figures on the number of CAVs operating in the EU are currently limited, the global count was approximately 21,150 units in 2023, with projections estimating an increase to 26,560 units in 2024 and 33,570 units by 2025. The European Commission has invested 159 million Euros since 2021 in research and innovation activities, supporting **19 European projects related to Connected, Cooperative, and Automated Mobility (CCAM)**. Currently, the EU automobile industry leads the global market for semi-automated vehicles,

[10] Horizon Grand View Research, Europe Autonomous Vehicle Market Size & Outlook, 2023-2030: https://www.grandviewresearch.com/horizon/outlook/autonomous-vehicle-market/Europe

specifically Level 1-2 vehicles, with plans to advance to Levels 3-4 through initiatives such as large-scale 'highway chauffeurs' on motorways and automated shuttles in urban areas[11], [12].

2.1.3. EXAMPLES OF CAV DEPLOYMENT

2.1.3.1. The Show Project

More than **80 CAVs were deployed in various sites across continental Europe** within the activities of the SHOW project, featuring PT shuttles, robo-taxis, delivery robots, freight vehicles and modular vehicles. The SHOW Use Cases aimed to define priority urban automated mobility scenarios for the project, serving as the key reference for its development and demonstrations. These Use Cases outlined activities at various Megaand Satellite sites, fulfilling functional requirements in order for their findings to be translated into the project's system architecture. They were grouped into three families: (1) automated mobility in cities, covering passenger and cargo transport under complex traffic conditions, interactions with non-automated vehicles and VRUs, and issues like sustainability and integration with Traffic Management Centers; (2) automated mixed mobility, focusing on using the same AV for both passenger and goods transport, either simultaneously or at different times to enhance fleet efficiency; and (3) added value services, offering functionalities like self-learning demand response, AI-based services, automated parking, and depot management to improve fleet operations and passenger experiences (Figure 2.4).

Figure 2.4: Real Life Operations of CCAM Services. The CAVForth Project

Source: SHOW project, 2024[13]

[11] European Commission, Directorate-General for Research and Innovation: https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/automated-mobility-europe-where-are-we-now-2024-04-17_en
[12] Global Newswire, Research and Markets: https://www.globenewswire.com/news-release/2024/03/11/2844051/28124/en/Analysis-of-Europe-s-Heavy-Duty-Autonomous-Vehicle-Market-2023-2032-Featuring-Profiles-of-AB-Volvo-Mercedes-Benz-Group-BMW-Group-ZF-Friedrichshafen-and-More.html
[13] SHOW project operations: https://show-project.eu/2024/11/06/show-project-concludes-paving-the-way-for-the-future-of-automated-urban-mobility/

Within the SHOW project, CAVs implemented for PT operations were analyzed. Specifically, data analyses combined real-world data from pilot sites and simulations, to assess the safety performance of automated vehicles (AVs) using statistical models and key performance indicators like hard braking events, conflict severity, and Time-To-Collision (TTC). Findings from ten minor crashes across SHOW pilot sites highlight that most incidents resulted from interactions with human drivers in complex environments, emphasizing the need for improved detection and communication systems. While acceleration variability increased erratic driving and illegal overtaking, it also helped shuttles adapt to traffic speeds, ultimately reducing conflicts. Statistical models revealed that higher speeds and acceleration fluctuations led to more hard braking events, with sites like Graz and Klagenfurt experiencing particularly high rates. AVs' lower speeds increased close interactions with other road users, leading to more frequent but less severe conflicts. Overall, AVs improved traffic safety by reducing the risk of serious incidents, though managing speed and acceleration remains a crucial task.

The CAVForth project was launched in May 2023, featuring one of the first **full-size public autonomous bus services**. The service utilizes five Alexander Dennis Enviro200AV buses along the AB1 route, linking Edinburgh Park with the Ferrytoll Park and Ride site in Fife via the Forth Road Bridge, and is operated by Stagecoach East Scotland. These buses operate at SAE Level 4 autonomy, meaning a driver is onboard but does not actively control the vehicle during normal operations. The service is expected to handle up to 10,000 passenger trips per week. An image of the autonomous bus is provided in Figure 2.5. The project is expected to contribute to the advent of automation, leading to considerable road safety and fuel efficiency improvements[14].

Figure 2.5: The CAVForth Autonomous Bus

2.1.3.2. The Driven Project

Oxa (formerly Oxbotica) is an autonomous vehicle software company, headquartered in Oxfordshire, England. They have deployed **a fleet of Ford Mondeo cars equipped with autonomous technology**, tested on public roads in Stratford, London, to assess their performance in urban environments. This pilot is part of the DRIVEN Project, which focuses on the development of self-driving cars. Oxa has been developing CAVs towards the direction of the physical AI concept, also fostered by NVIDIA, which enables autonomous systems such as CAVs to perceive, understand, and perform complex actions in the real (physical) world.

[14] UK Society of Motor Manufacturers and Traders (SMMT): https://www.smmt.co.uk/back-automated-vehicles-bill-to-unlock-multi-billion-uk-self-driving-revolution/

2.1.4. EXPECTED ROAD SAFETY BENEFITS OF CAVS

Connected and Automated Vehicles (CAVs) are a priori widely expected to considerably elevate road safety levels by reducing crashes and mitigating injuries. In Europe, CAVs are **projected to significantly enhance road safety by reducing crashes primarily caused by human error**, which accounts for over 90% of traffic incidents on European roads. The European Commission anticipates that automated driving will substantially decrease road fatalities and injuries, addressing the current annual toll of more than 40,000 deaths and 1.5 million injuries[15]. Additionally, CAVs are expected to exhibit lower reaction times and more consistent driving behavior, especially when equipped with vehicle-to-vehicle communication capabilities[16]. This technological advancement enables CAVs to adhere strictly to traffic regulations, such as speed limits and traffic signals, thereby further mitigating crash risks.

Overseas, relevant research suggests that widespread adoption of automated driving and connected vehicle safety applications could prevent between 4,100 and 6,500 fatal and serious injury crashes annually in Australia, and 310 to 485 such crashes each year in New Zealand. Additionally, Cooperative Intelligent Transport Systems (C-ITS) applications could lead to a 35-50% reduction in adjacent-direction crashes at intersections by providing timely collision risk warnings. Opposing-direction crashes could also be reduced by up to 40% through alerts about potential oncoming vehicle collisions[17].

The effectiveness of **Advanced Driver Assistance Systems (ADAS)** further reinforces the potential safety benefits of CAVs. Lane departure warning and prevention systems could prevent 28-32% of road departure crashes in the United States, while forward collision warning systems have been linked to a 27% reduction in front-to-rear crashes and a 20% decrease in related injuries[18]. Automated Emergency Braking (AEB) has demonstrated a 38% reduction in rear-end collisions, with projections from the U.S. National Highway Traffic Safety Administration (NHTSA) indicating that expanding AEB functionality to speeds of up to 62 mph by 2029 could save 360 lives and prevent 24,000 injuries annually[19]. While these findings highlight the transformative potential of CAVs, their real-world impact will depend on adoption rates, technological advancements, regulatory policies, and integration into existing transportation systems.

However, achieving similar road safety improvements through CAV adoption in regions such as the EaP countries will strongly depend on first overcoming substantial regional-specific barriers. These include significant infrastructural inadequacies, older vehicle fleets lacking essential connectivity features, limited public awareness of automated technologies, and currently incomplete regulatory frameworks. Thus, targeted investments in infrastructure, fleet modernization, regulatory reforms, and public education campaigns will be critical preconditions for realizing anticipated safety benefits.

[15] European Parliament, January 2016 Briefing: https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573902/EPRS_BRI%282016%29573902_EN.pdf

[16] LEVITATE project: Road safety impacts of Connected and Automated Vehicles: https://levitate-project.eu/wp-content/uploads/2021/06/Road-safety-impacts-of-Connected-and-Automated-Vehicles.pdf

[17] Monash University: New research underlines the importance of connected and automated driving to reduce road trauma: https://www.monash.edu/muarc/news-and-events/articles/importance-of-connected-and-automated-driving

[18] Center of Excellence on New Mobility and Automated Vehicles (Mobility COE): https://www.mobilitycoe.org/literature-review/automated-vehicles-safety/

[19] American Automobile Association, 2024: Progression of Automatic Emergency Braking Technology: https://newsroom.aaa.com/wp-content/uploads/2024/10/REVISED-10-17-24-Full-Research-Report-Progression-AEB-Technology.pdf

CHALLENGES

Despite the expectations, the full safety benefits of these technologies are uncertain, as many variables remain unclear, such as the effectiveness of automation in real-world conditions. While CAVs are expected to reduce human errors leading to crashes, there are still **challenges related to sensor technology, infrastructure, and public acceptance** that need to be addressed before widespread implementation can occur. The transition to fully automated systems may be non-linear, with the potential obsolescence of human drivers and more reliance on automated systems. The exact safety impact of CAVs remains unclear due to numerous unknowns in how they interact with human drivers and existing infrastructure (ERSO, 2018). The introduction of CAVs also poses new challenges, including cybersecurity risks and the need for updated legislation regarding liability. The successful integration of these technologies will require substantial improvements in public trust, road safety standards, and ongoing technological advancements.

Another significant concern is **cybersecurity**, as the integration of advanced software in vehicles exposes them to potential hacking and data breaches, compromising user safety and privacy. Additionally, ensuring reliable network connectivity is vital for real-time data exchange between vehicles and infrastructure, yet maintaining consistent and secure connections remains a technical hurdle. Managing the vast amounts of data generated by CAVs also poses challenges, necessitating robust data processing and storage solutions to handle the information flow effectively[20].

In the EU, these challenges are particularly pronounced due to the region's **diverse infrastructure and regulatory landscape**. The varied road infrastructures across member states require harmonized standards and interoperability to ensure seamless operation of CAVs. Moreover, addressing cybersecurity risks is paramount, as the reliance on software and connectivity makes vehicles susceptible to cyber threats[21].

Furthermore, the **ethical and legal implications of CAVs** present unique challenges within the EU. Determining liability in the event of crashes involving automated systems requires clear regulations and standards, which are still under development. The EU's commitment to shaping digital futures includes addressing these legal complexities to facilitate the integration of CAVs into existing transportation systems. Public acceptance is also crucial; ensuring that citizens trust and are willing to adopt these technologies necessitates transparent policies and public engagement. The EU's approach to connected and automated mobility underscores the importance of balancing technological advancement with ethical considerations and user trust to successfully navigate the challenges posed by CAVs[22].

2.2. ELECTRIC VEHICLES

Electric vehicles (EVs) are vehicles which are powered wholly or partly by electricity instead of traditional combustion engines. These vehicles utilize electric motors powered by rechargeable batteries or alternative energy storage systems like fuel cells. EVs come in several varieties: (i) Battery Electric Vehicles (BEVs) run completely on electricity; (ii) Plug-in Hybrid Electric Vehicles (PHEVs) combine electric motors with conventional engines; and (iii) Hybrid Electric Vehicles (HEVs) use both fuel and electricity but lack plug-in

[20] Semiconductor Engineering: Growing Challenges For Increasingly Connected Vehicles https://semiengineering.com/growing-challenges-for-increasingly-connected-vehicles/

[21] The FAME & the ARCADE project: EC Action Plan for automotive industry aims to get autonomous vehicles on Europe's roads faster. https://www.connectedautomateddriving.eu/blog/ec-action-plan-for-automotive-industry/

[22] European Commission: Connected and automated mobility https://digital-strategy.ec.europa.eu/en/policies/connected-and-automated-mobility

capability. As a crucial innovation for environmental sustainability, EVs help reduce carbon emissions, enhance energy efficiency, and support greener transportation solutions.

2.2.1. ELECTRIFICATION

Overall, the **transportation sector accounts for approximately 24% of direct CO_2 emissions** from fuel combustion globally[23]. The electrification of transport represents one of the most effective strategies for decarbonization:

a. A lifecycle analysis concluded that EVs produce significantly lower emissions than conventional vehicles, even when accounting for battery production and electricity generation[24]
b. The carbon advantage grows as electricity grids incorporate more renewable energy sources[25]
c. Electrification dramatically reduces harmful local air pollutants like nitrogen oxides, particulate matter, and ground-level ozone that contribute to respiratory diseases and premature deaths in urban areas[26]

The electrification of transport fleets represents a fundamental shift in how power mobility is powered, promising substantial environmental, economic, and social benefits, accompanied by unique challenges. According to the International Energy Agency (IEA), **global electric car sales** reached 10.5 million in 2022, representing a 55% increase from 2021[27]. This growth trajectory continued into 2023, with electric vehicles (EVs) accounting for approximately 14% of all new car sales worldwide.

The momentum extends beyond personal vehicles. **Commercial fleet operators, public transit agencies, and logistics companies** are increasingly adopting electric alternatives:

a. Public transit systems in cities like Shenzhen, China have converted to 100% electric bus fleets[28]
b. Major logistics companies including FedEx, Amazon, and UPS have committed to electrifying significant portions of their delivery fleets[29]
c. Electric two-wheelers and three-wheelers have achieved market dominance in several Asian markets[30]

2.2.2. EU FIGURES

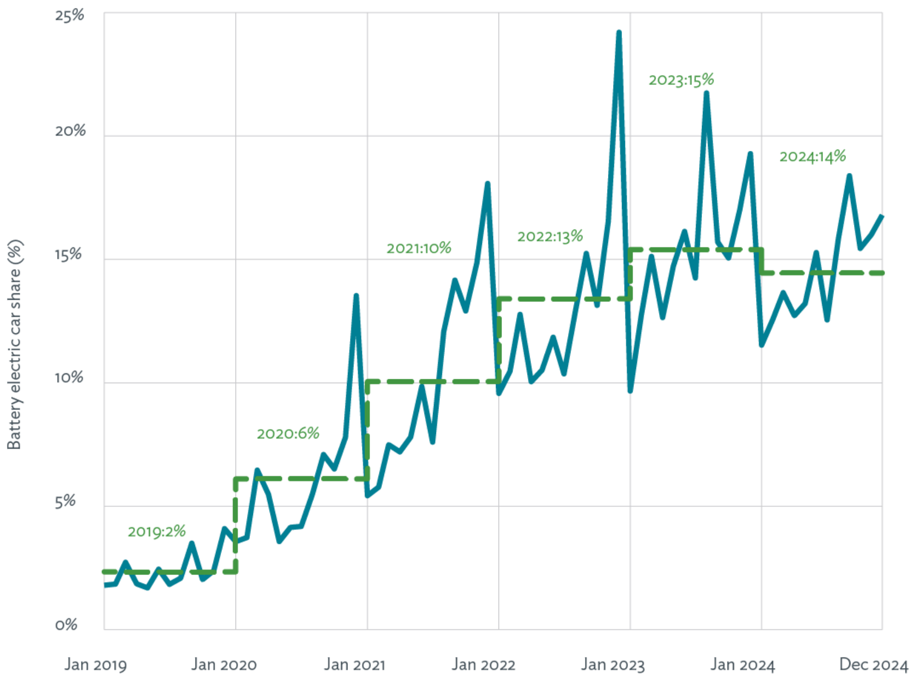
The EV market in the EU has grown steadily over the past five years, rising from a small share in 2019 to 15.5% in 2024. This growth coincides with an increase in renewable energy use for transport, which went from

[23] Climate Change 2022: Mitigation of Climate Change: https://www.ipcc.ch/report/ar6/wg3/
[24] Union of Concerned Scientists (2022): Driving Cleaner report. https://www.ucs.org/sites/default/files/2022-07/driving-cleaner-report_0.pdf
[25] McKinsey & Company: How grid operators can integrate the coming wave of renewable energy https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/how-grid-operators-can-integrate-the-coming-wave-of-renewable-energy
[26] World Health Organization. (2023). Transport, Environment and Health: https://www.who.int/europe/news-room/fact-sheets/item/transport-health-and-environment
[27] IEA. (2023). Global EV Outlook 2023. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2023
[28] IAA Mobility Reports: https://www.iaa-mobility.com/en/newsroom/news/sustainability/shenzen-the-city-of-green-future
[29] Sustainability Magazine: Top 10 Sustainable Transport and Logistics Companies: https://sustainabilitymag.com/supply-chain-sustainability/top-10-sustainable-transport-and-logistics-companies
[30] Electrified Transport Market Outlook 4Q 2023: Growth Ahead: https://about.bnef.com/blog/electrified-transport-market-outlook-4q-2023-growth-ahead/

under 2% in 2005 to 10.2% in 2020, according to the European Environment Agency (EEA). Collectively, the EU Member States reached the 10% target for the share of energy from renewable sources in the transport sector.

To boost the adoption of EVs, a range of measures have been implemented across Europe, as outlined in the European Environment Agency's SOER 2020 report[31]. These include financial support for the EV industry, public investments in charging infrastructure and subsidies for home chargers, and the procurement of electric vehicles for municipal fleets. Additionally, states have provided aid for electrifying public transport and introduced indirect consumer incentives such as access to bus lanes, free or preferential parking, entry into low-emission zones, complimentary public charging, and toll exemptions. Public awareness campaigns and educational initiatives have also played a role, alongside regulatory strategies like setting sales targets for EV manufacturers or phasing out internal combustion engine vehicle sales (Figure 2.6).

Figure 2.6: Share of battery electric in new passenger car registrations in Europe



Source: ICCT20[32]

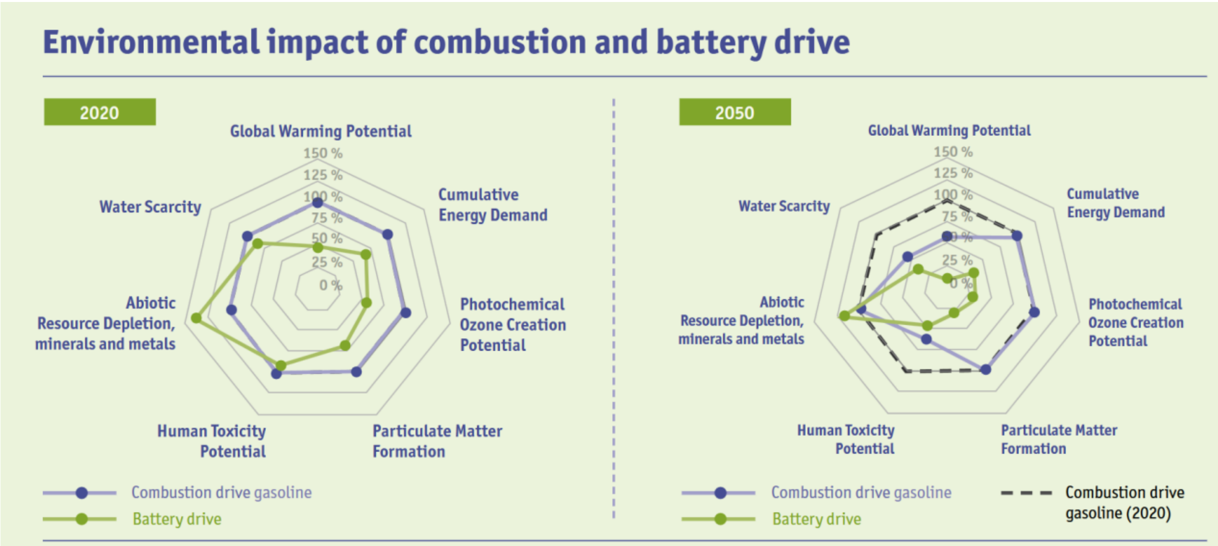
2.2.3. EV EXPECTED ENVIRONMENTAL AND ROAD SAFETY IMPACTS

The **environmental impact of EVs is multifaceted and complex** and often investigated or calculated at various levels (e.g. vehicle production level versus operational-only level). Nonetheless, for more fair comparisons to internal combustion engines (ICEs), a more holistic approach is preferrable, accounting for the end-to-end EV lifecycle from production to retirement. Such analyses have been conducted in the academic and industrial literature and compiled within a detailed information paper by the European Environmental Bureau (EEB), the Environmental Coalition on Standards (ECOS) and the Environmental Action Germany (DUH)[33].

[31] European Environment Agency, The European environment — state and outlook 2020: https://www.eea.europa.eu/soer/2020
[32] ICCT20, European Market Monitor: Cars and vans 2024: https://theicct.org/publication/european-market-monitor-cars-vans-2024-feb25/
[33] What is the environmental impact of electric cars? ECOS, EEB, DUH information paper. Available: https://eeb.org/wp-content/uploads/2023/02/230203_DUH_EEB_ECOS_Information-Paper_Env.-Impact-Electric-Cars.pdf

That study determined that throughout the entire lifecycle, CO_2 emissions of EVs range from 75-160 g/km, while the respective values for ICE vehicles rise to 200-250 g/km[34, 35, 36]. Therefore, even at the most conservative estimates, there is a saving of 40 g/km in CO_2 emissions. Additionally, the nitrogen (NO_x) and sulfur oxide (SO_x) emissions are all but eliminated when switching to electric locomotion. The efficiency of transmission of motion from the engine to the wheel is higher in EVs, surpassing the 15%-24% of fossil fuels to rise to 45% by employing the current mix of electricity or even to 77% when using green electricity[33]. When the entire lifecycle is considered, ICEs also consume more water, the most critical part of which relates to crude oil but also battery lithium extraction. A comparative overview of wider environmental benefits, including water and mineral impacts, is presented in Figure 2.7.

Figure 2.7: Comparison of the lifecycle assessment of EVs and ICEs from 2020 to 2050



Source: ECOS, EEB, DUH[33] and EC[37]

Regarding road safety, EVs bring both opportunities and challenges to the field. On the positive side, EVs are generally equipped with advanced driver-assistance systems (ADAS), regenerative braking, and low centers of gravity due to battery placement, which can improve handling and reduce rollover risk. Their quiet operation also reduces noise pollution, contributing to more pleasant urban environments. However, this quietness can pose a risk to pedestrians and cyclists, particularly those with visual impairments, as EVs are harder to hear at low speeds—leading to regulations in many countries requiring artificial sound generators. Additionally, EVs' high torque delivery can cause abrupt acceleration if not properly managed. The weight of EV batteries may also contribute to increased crash severity in multi-vehicle collisions.

EV safety is also uniquely influenced by battery integrity; while rare, thermal runaway or battery fires present specific risks during and after crashes. That said, EVs are obliged to meet the same safety standards as internal

[34] EEA Report 13/2018: Electric vehicles from life cycle and circular economy perspectives - TERM 2018 https://www.eea.europa.eu/en/analysis/publications/electric-vehicles-from-life-cycle

[35] The International Council on clean Transportation (2021): A Global Comparison of the Life-Cycle Greenhous Gas Emissions of Combustion Engine and Electric Passenger Cars. Available: https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/

[36] Pipitone E., Caltabellotta S., Occhipinti L. (2021) A Life Cycle Environmental Impact Comparison between Traditional, Hybrid, and Electric Vehicles in the European Context, Sustainability 2021, 13, 10992. https://doi.org/10.3390/su131910992

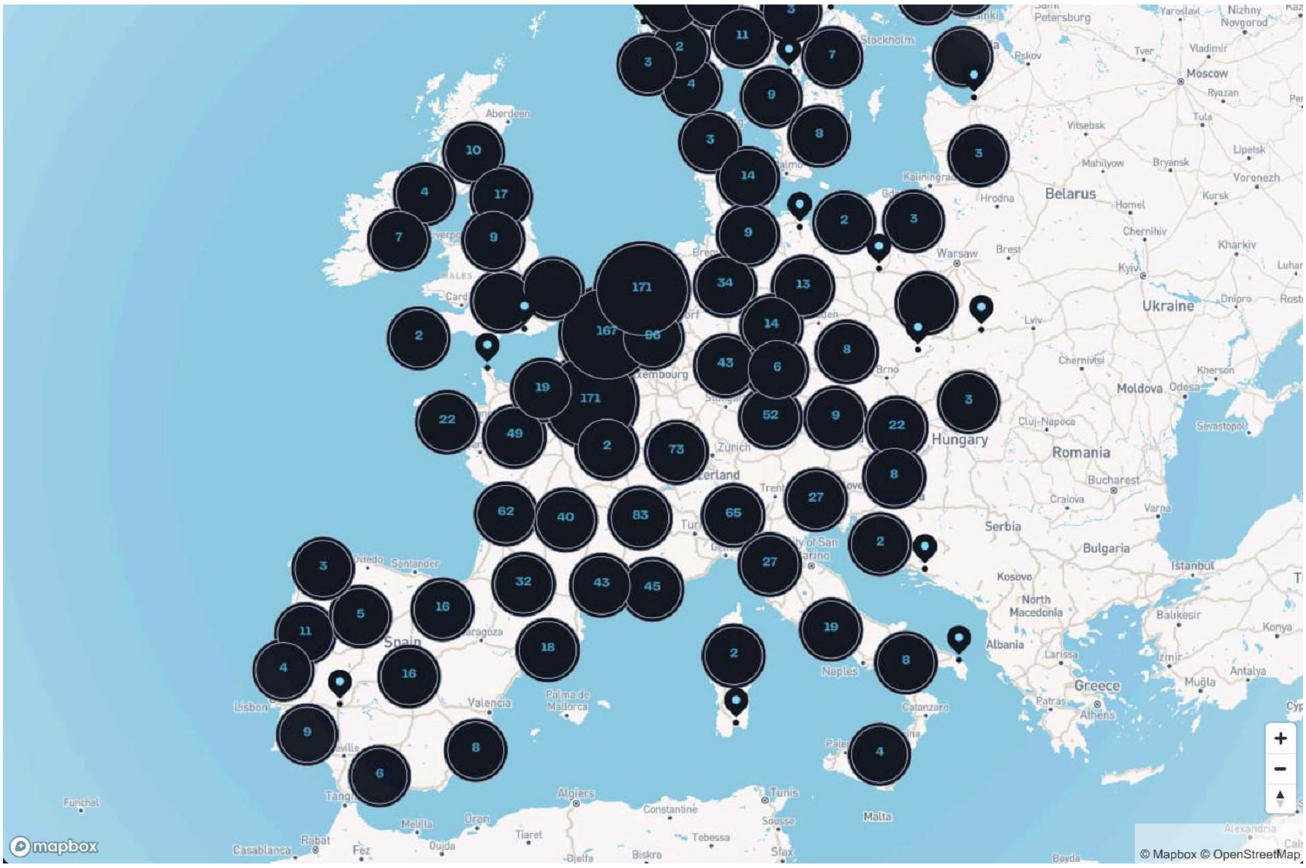
[37] European Commission (2020) Determining the environmental impacts of conventional and alternatively fueled vehicles through LCA: https://op.europa.eu/en/publication-detail/-/publication/1f494180-bc0e-11ea-811c-01aa75ed71a1/language-en

combustion vehicles, and many score high in crash tests. Overall, with appropriate infrastructure, regulation, and public awareness, EVs have all prerequisites to contribute positively to road safety outcomes[38].

2.2.4. EXAMPLES OF EV DEPLOYMENT

The EU has enabled and witnessed significant strides in electric vehicle (EV) deployment, accompanied by notable environmental and infrastructural impacts. One of the key challenges is the transition from gas/petrol stations to EV charging stations, and the proliferation of the latter. A prominent example towards expanding the EV penetration via increased charging supply is the collaborative effort among four major European EV charging firms—Italy's Atlante, Germany's Ionity, the Netherlands' Fastned, and France's Electra—to form an alliance named Spark. This initiative aims to create Europe's largest public charging network, integrating 11,000 charging points and 1,700 stations across 25 countries (Figure 2.8), thereby addressing consumer concerns over EV driving ranges and promoting adoption rates[39].

Figure 2.8: Spark Alliance Charging Point Coverage



Source: Spark Alliance[40]

Regarding Heavy-Duty EVs, BMW introduced Europe's first 40-tonne fully electric truck to transport automotive parts between facilities in Munich. This vehicle, capable of traveling up to 100 km on a single

[38] RoSPA Synthesis: Electric Vehicle Safety. Available: https://www.rospa.com/media/documents/road-safety/road-observatory/Vehicles-Electric-vehicle-safety.pdf
[39] Reuters: EV charging firms team up to launch Europe's largest network https://www.reuters.com/business/autos-transportation/ev-charging-firms-team-up-launch-europes-largest-network-2025-04-02/
[40] Spark alliance https://sparkalliance.com/

charge which takes around 3-4 hours to complete, demonstrates the feasibility of electrifying heavy-duty transport; its initial loads will include vehicle components. It will lower CO_2 emissions and operate more quietly. This single electric truck, shown in Figure 2.9, is expected to save 11.8 tons of CO_2 annually[41]. On a similar vein, DHL aims to double the number of its electric deliveries in Budapest. The addition of these new electric vans will reduce DHL Express Hungary's entire CO_2 emissions by more than 10%[42].

On the production front, Audi's facility in Brussels, Belgium, stands out as the first certified carbon-neutral high-volume EV factory by the European Commission. The plant incorporates eco-friendly measures, including a photovoltaic farm generating 3,000 megawatt-hours annually and the use of biogas for heating, exemplifying the industry's move towards sustainable manufacturing practices throughout the EV lifecycle[43].

In urban settings, innovative projects like MetroCharge in Barcelona have been implemented to support EVs, utilizing energy generated from the braking of subway trains, which is transmitted to power stations and charge electric vehicles. This system not only enhances energy efficiency but also supports the shift to electric mobility, reflecting a commitment to sustainable urban transport solutions. Initiatives of these kinds emerge in light of growing pressures caused by climate change, such as those that manifest in Spain[44].

Figure 2.9: BMV Electric Truck

Source: The Verge[45]

2.2.5. CHALLENGES

Despite rapid progress, several challenges remain for EV market penetration and wider progress. First and foremost, widespread electrification will require **significant upgrades to electrical distribution systems and strategic deployment of charging infrastructure**. Smart charging technologies and vehicle-to-grid capabilities

[41] Wired: BMW's 40-tonne electric truck hits public roads https://www.wired.com/story/bmw-40-tonne-electric-truck
[42] Budapest Business Journal: DHL Doubles Electric Van Fleet in Budapest https://bbj.hu/business/industry/automotive/dhl-doubles-electric-van-fleet-in-budapest
[43] Wired: Audi's New Electric-Car Factory Goes Green. https://www.wired.com/story/audi-e-tron-green-factory
[44] Euronews Barcelona's metro trains are helping to charge the city's EVs each time they brake: https://www.euronews.com/next/2024/12/20/barcelona-is-turning-its-metro-trains-into-ev-chargers-thanks-to-regenerative-brakes
[45] The Verge: BMW is first to deploy an electric 40-ton truck on European roads: https://www.theverge.com/2015/7/10/8927489/bmw-electric-truck-europe-terberg

will be essential for managing demand and providing grid services[46]. After all, distance autonomy remains a critical concern for EV adoption by the general public[47].

It is worth noting that supply chains, which are necessary for EV production, are constantly readjusting in response to major events (e.g. conflicts or trade agreements). Securing sustainable and ethical supply chains remains a challenge, though recycling initiatives and alternative battery configurations, such as solid-state batteries[48], show promise for reducing dependency on scarce resources.

Moreover, issues of **transport equity, inclusivity and accessibility arise in EV adoption** as well. Ensuring that the benefits of transport electrification are accessible across socioeconomic groups and geographic regions requires thoughtful policy approaches. Even more importantly, there are indications that at present, the benefits of EV technology are largely concentrated among more affluent segments of society, particularly in regions where EV adoption is widespread. In contrast, many of the negative impacts associated with EVs—across their production, use, and disposal—tend to disproportionately affect marginalized communities.

As a result, the development of **the EV sector risks reinforcing existing inequalities, exclusion, and poverty** within an already unsustainable mobility system[49]. Without intentional planning at the local, prefectural, governmental but also international levels, there is a risk that the transition could exacerbate existing transportation inequities. Therefore, a challenge of defining common values and coordinating towards their enhancement arises for contemporary transport policymakers.

2.3. BIG DATA AND AI APPLICATIONS

Recent rapid advancements in computing and algorithm development have significantly impacted road safety, alongside all areas of transport. Big data and Artificial Intelligence (AI)-driven modeling has become more accessible, enabling road safety professionals to apply increasingly advanced algorithms to better understand and improve safety outcomes across networks. Big data and AI are transforming real-time road safety by enabling faster, more accurate, and predictive decision-making in transport systems. Using vast datasets gathered from connected vehicles, road sensors, mobile devices, traffic cameras, and infrastructure, AI algorithms can detect patterns, anticipate risks, and optimize traffic flow. For instance, machine learning models analyze vehicle speeds, braking behaviors, and near-miss incidents to identify hazardous locations or predict potential collisions before they occur. At the same time, data collection has evolved to become more cost-effective, continuous, and diverse, moving beyond traditional indicators like crashes and fatalities. Instead, the focus is shifting toward high-frequency surrogate safety metrics, such as harsh braking, Time-To-Collision (TTC), and detailed driver behavior data, which offer deeper insights into real-time safety performance.

Real-time traffic monitoring platforms powered by AI can dynamically adjust traffic signals, reroute vehicles to avoid congested or dangerous areas, and even alert emergency services instantly in case of crashes. In

[46] National Renewable Energy Laboratory. (2023). Electric Vehicle Grid Integration. Available: https://www2.nrel.gov/transportation/project-ev-grid-integration
[47] Javadnejad, F., Jahanbakh, M., Pinto, C. A., & Saeidi, A. (2024). Analyzing incentives and barriers to electric vehicle adoption in the United States. Environment Systems and Decisions, 44(3), 575-606.
[48] Shah, R., Mittal, V., & Precilla, A. M. (2024). Challenges and advancements in all-solid-state battery technology for electric vehicles. J, 7(3), 204-217.
[49] Rouhana, F., Zhu, J., Chacon-Hurtado, D., Hertel, S., & Bagtzoglou, A. C. (2024). Ensuring a just transition: The electric vehicle revolution from a human rights perspective. Journal of Cleaner Production, 462, 142667.

addition, AI-driven video analytics detect violations such as red-light running or illegal turns, enhancing enforcement and deterrence. Examples of these technologies in action include platforms like GM & INRIX[50], TomTom Traffic, and various city-wide intelligent traffic management systems in places like Barcelona, Amsterdam, and Helsinki.

Furthermore, EU projects such as C-Roads, which concern the deployment of connected ITS services[51], and Data for Road Safety, which concerns the formulation of a forum for road safety data exchange across Europe[52], are leading the way in integrating these technologies into public infrastructure. In the following sections, several technological advancements that fall within the big data and AI-enhanced road safety domains are elaborated.

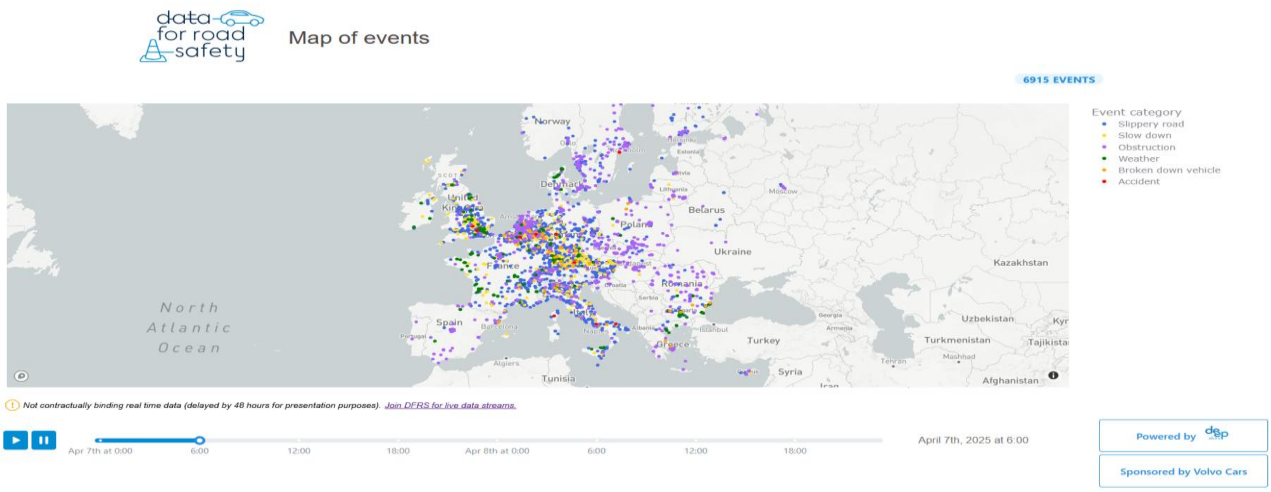
2.3.1. EU-WIDE SAFETY-RELATED TRAFFIC INFORMATION (SRTI)

Under the framework of Directive 2010/40/EU, the European Union has established specifications to guarantee compatibility, interoperability, and seamless deployment of Intelligent Transport Systems (ITS) for delivering EU-wide safety-related traffic information (SRTI) and real-time traffic information (RTTI) services. Achieving this goal requires the active participation of a wide range of stakeholders, including vehicle manufacturers, traffic information service providers, automotive suppliers, and public authorities. The SRTI Ecosystem facilitates seamless data exchange among these partners, enabling the widespread delivery of safety-related traffic information services.

To support this action, Member States are required to establish and operate National Access Points (NAPs), ensuring that relevant data is easily accessible for exchange and reuse across systems and stakeholders. The **National Access Point Coordination Organisation for Europe (NAPCORE)** project was launched in 2022[53]. It was established to enhance the consistency and alignment of EU specification implementation across Member States. Co-funded by the EU through the Connecting Europe Facility, NAPCORE serves as a coordination mechanism to strengthen the interoperability of NAPs, which are key to facilitating mobility data exchange across Europe. By promoting standard harmonization, coordinated data access, and improved alignment of NAPs, NAPCORE works to increase both the accessibility and availability of mobility-related data, ultimately supporting more efficient and integrated transport systems across the EU[54].

[50] Safety View by GM Future Roads & INRIX: https://inrix.com/products/safety-view-by-gm-future-roads-and-inrix/
[51] C-Roads - The Platform of harmonised C-its deployment in Europe: https://www.c-roads.eu/platform.html
[52] Safety Related Traffic Information Ecosystem: Data for Road Safety: https://www.dataforroadsafety.eu/
[53] European Commission: Safety-Related Traffic Information (SRTI) & Real-Time Traffic Information (RTTI) https://transport.ec.europa.eu/transport-themes/smart-mobility/road/its-directive-and-action-plan/safety-related-traffic-information-srti-real-time-traffic-information-rtti_en
[54] NAPCORE project: https://napcore.eu/

Figure 2.10: SRTI Live Data for Road Safety



Source: SRTI[55]

2.3.2. PREDICTIVE ANALYTICS FOR CRASH PREVENTION

Predictive analytics systems represent a significant advancement in proactive road safety management by leveraging advanced machine learning algorithms to process vast datasets from multiple sources including traffic cameras, weather stations, vehicle telematics, and historical crash records. These systems can **identify unsafe or otherwise high-risk locations with high accuracy** under various conditions, allowing for targeted interventions before road crashes occur. Example approaches include creating video image processing systems, installing in-situ or remote sensors[56], fusing sensor data, selecting representative traffic KPIs or a mix of the above. Subsequently, the data trained with a classifier, with the purpose of the classifier being able to discriminate and categorize real-time or near real-time data into either normal or pre-crash conditions[57]. More recent advances reduce the necessary image resolution, allowing for more disaggregate analyses[58] and, therefore, more direct responses by the road authorities.

Moreover, targeted Vulnerable Road User (VRU) protection systems employ specialized computer vision algorithms and sensor networks to identify pedestrians, cyclists, and other unprotected road users who face disproportionate injury risks in traffic environments. The concept is visualized in

Figure 2.11, highlighting both the centralized processing and field processing aspects of the process. Indicatively, proposed approaches to advance these concepts consider the estimation of a predictive collision risk area (PCRA) beforehand from video data, additionally dividing by injury severity levels59.

[55] SRTI Data for Road Safety, DFRS live map: https://www.dataforroadsafety.eu/

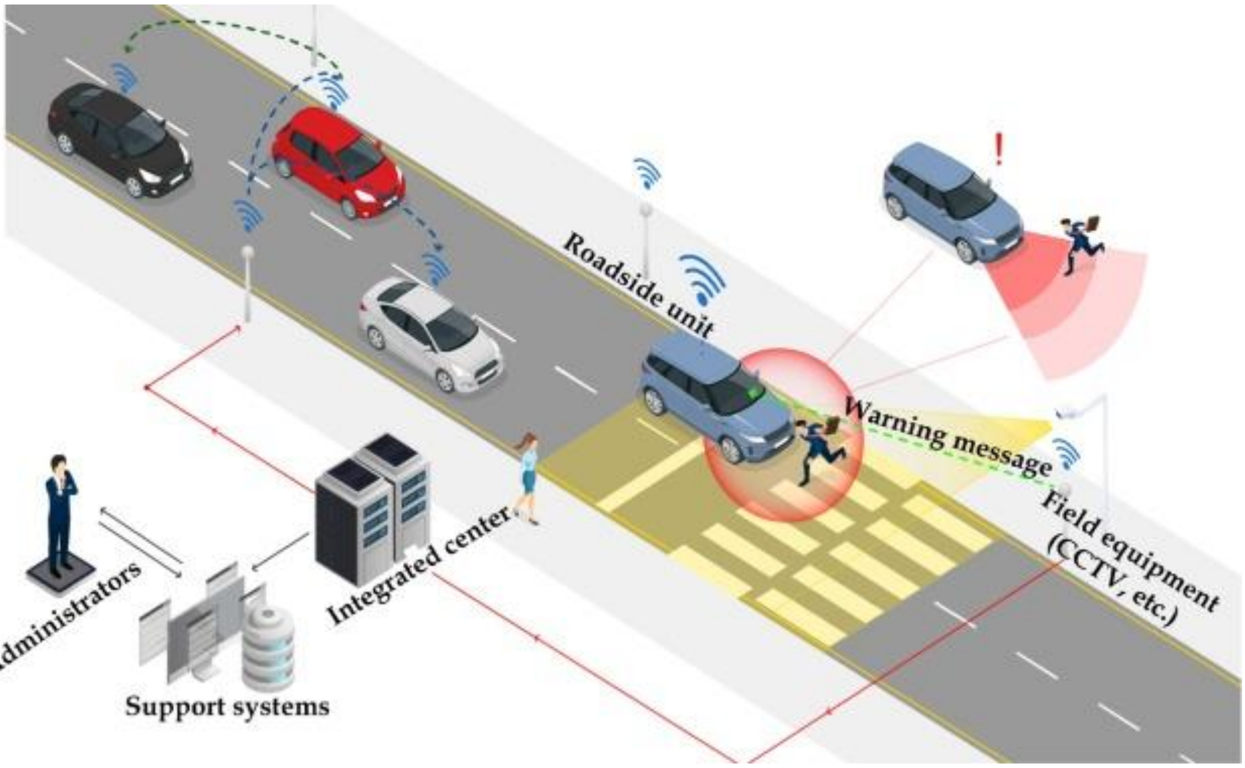
[56] Stylianou, K., Dimitriou, L., & Abdel-Aty, M. (2019). Big data and road safety: A comprehensive review. Mobility Patterns, Big Data and Transport Analytics, 297-343.

[57] Hossain, M., Abdel-Aty, M., Quddus, M. A., Muromachi, Y., & Sadeek, S. N. (2019). Real-time crash prediction models: State-of-the-art, design pathways and ubiquitous requirements. Accident Analysis & Prevention, 124, 66-84.

[58] Basso, F., Pezoa, R., Varas, M., & Villalobos, M. (2021). A deep learning approach for real-time crash prediction using vehicle-by-vehicle data. Accident Analysis & Prevention, 162, 106409.

[59] Noh, B., & Yeo, H. (2022). A novel method of predictive collision risk area estimation for proactive pedestrian accident prevention system in urban surveillance infrastructure. Transportation research part C: emerging technologies, 137, 103570.

Figure 2.11: Overall approaches to protect VRUs from traffic incidents



Source: Noh and Yeo, 2022[59]

The adoption of AI in road safety boosts driver awareness with real-time alerts, enhances adherence to traffic laws, and delivers a 94% precision-recall rate in detecting road signs. This technology fosters safer driving behavior and substantially lowers the risk of crashes[60]. Advanced ML models can also enhance traditional econometric models, and with averaging of predictions in a vote-count manner, a more balanced and accurate output can be obtained[61].

Technologies such as **driving alerts, drowsiness detection, and gaze monitoring** serve as examples of early collision prediction tools. Numerous analytic methods have been proposed in the literature, including classification techniques and Convolutional Neural Network (CNN)-based driver gaze-estimation approaches[62], which have demonstrated promising results[63].

[60] Manasia, L., Bharmal, M., Singhvi, H., Mehta, G., Gawade, A., Rathod, N., & Florence, A. A. (2024). AI Drive Assist: Enhancing Road Safety through Advanced Road Sign Detection and Driver Alerts. Journal of Computer Science, 20(8), 885–897. https://doi.org/10.3844/jcssp.2024.885.897
[61] Ziakopoulos, A., Vlahogianni, E., Antoniou, C., & Yannis, G. (2022). Spatial predictions of harsh driving events using statistical and machine learning methods. Safety science, 150, 105722.
[62] Sharma, P. K., & Chakraborty, P. (2024). A review of driver gaze estimation and application in gaze behavior understanding. Engineering Applications of Artificial Intelligence, 133, 108117.
[63] Yoon, H. S., Baek, N. R., Truong, N. Q., & Park, K. R. (2019). Driver gaze detection based on deep residual networks using the combined single image of dual near-infrared cameras. IEEE Access, 7, 93448-93461.

2.3.3. INTELLIGENT INFRASTRUCTURE

Intelligent transportation infrastructure integrates sensors, cameras, edge computing devices, and communication systems directly into roadways and urban environments to create roads that actively participate in traffic and safety management rather than serving as passive surfaces.

2.3.3.1. Smart Motorways

In the **UK, Smart Motorways (SMs)** represent a category of motorway infrastructure that differs from traditional designs through three main configurations. These include: (i) Controlled Motorways (CM), which retain the permanent hard shoulder but introduce mandatory variable speed limits to regulate traffic flow; (ii) All Lane Running (ALR) motorways, where the hard shoulder is permanently converted into a running lane alongside variable speed limits and designated emergency areas (Figure 2.12); and (iii) Dynamic Hard Shoulder Running (DHS) motorways, which use the hard shoulder as a live lane only at certain times, supported by variable speed limits. These designs aim to boost traffic capacity, with estimates suggesting that Smart Motorways can increase road capacity from up to a third compared to conventional layouts.

Currently, SMs in the UK span 488 miles, with an additional 300 miles planned by 2025 that will exclude traditional hard shoulders[64]. These motorways incorporate technologies such as mandatory speed limits, automatic traffic signal control based on real-time conditions, and enforcement through automated cameras. They are overseen by Regional Control Centers (RCCs), which are equipped to dispatch traffic officers promptly in the event of incidents[65]. SMs have demonstrated an improvement in journey reliability of up to 22%[66]. Furthermore, they contribute to environmental benefits, including a reduced global warming potential, particularly during safety barrier maintenance. These environmental gains are projected to grow as annual average daily traffic (AADT) and vehicle platooning rates increase[67], aligning with future traffic trends and supporting the long-term sustainability of SM infrastructure.

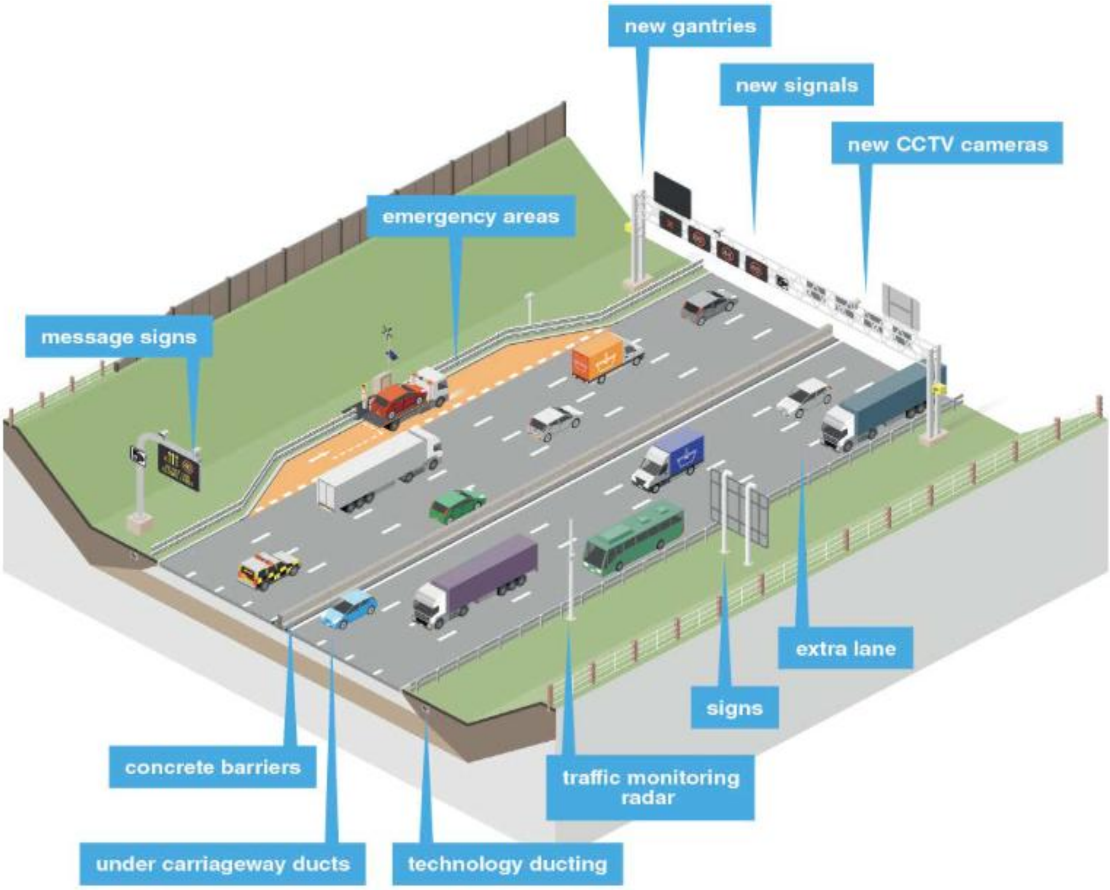
In numerous pilot trials conducted under the C-Roads platform, **C-ITS have been deployed** using ETSI ITS-G5 short-range communication technology, which functions similarly to Wi-Fi routers. ETSI ITS-G5 refers to a technology developed by the European Telecommunications Standards Institute (ETSI) concerning an Intelligent Transportation System (ITS) featuring G5, referring to the 5.9 GHz frequency band, which is designated in Europe for vehicular communications. It has particular applications in C-ITS to support safety-critical and time-sensitive data exchange.

By 2020, this technology had been implemented across more than 100,000 km of motorways in **18 EU Member States and 7 associated countries**. Notably, both C-Roads and C-ITS possess “day-1” readiness, meaning they are immediately available to support the deployment of CAVs from the outset[68]. The C-Roads initiative, involving most EU member states, the UK, and Norway, is focused on deploying smart motorways across Europe. Austria has led the way with a 2018 tender and a prominent role in the Austrian Road Safety Strategy

[64] UK Royal Automobile Club (RAC), “Which motorways are smart motorways, and where will new ones be?”. https://www.rac.co.uk/drive/advice/driving-advice/smart-motorways/
[65] Highways England, Smart Motorways Programme Environmental Assessment Report, 2019.
[66] The Royal Society for the Prevention of Accidents (ROSPA), Road Safety Factsheet – Smart Motorways, 2021. https://www.rospa.com/media/documents/road-safety/factsheets/smart-motorways-factsheet.pdf
[67] M. Guerrieri, B.M.L. Casto, G. Peri, and G. Rizzo, “Smart vs conventional motorways: Environmental impact assessment under realistic traffic conditions”, Science of the Total Environment, vol. 727, 2020, 138521.
[68] C-Roads, Annual pilot overview report 2020, 26 June 2021; C-Roads, The C-Roads Platform – An overview of harmonised C-ITS deployment in Europe, 2020. https://www.c-roads.eu/fileadmin/user_upload/media/Dokumente/C-Roads_Brochure_2021_final_2.pdf

2021-30. Italy has followed suit with technical tests on the A22 motorway, aiming to create a digital system for self-driving trucks, and is also working on a smart infrastructure project on the Salerno-Reggio Calabria motorway, which includes green energy EV charging stations. In June 2022, Stellantis launched the Arena del Futuro, a test track with inductive charging built on Italy's A35 Bre-Be-Mi motorway, designed to charge vehicles like the Fiat 500 wirelessly at highway speeds. Despite these advancements, public knowledge of smart motorways remains limited, with surveys showing that 25% of drivers are unaware of what smart motorways are, and another 27% are unaware of the related driving rules[69].

Figure 2.12: All Lane Running Smart Motorway Components



Source: UK DfT[70]

Overall, evidence indicates that smart motorways are generally as safe as or safer than conventional motorways, particularly in terms of reduced fatality rates. However, this improved safety record is not universal across all metrics. While fatal casualties have decreased, injury rates appear to be slightly higher. A notable safety concern is the increased risk associated with live lane breakdowns, where vehicles stop in active lanes without a hard shoulder. Additionally, public confusion over the various types of smart motorways and their differing rules has emerged as a significant issue impacting both safety and user confidence[70].

---

[69] Yannis, G. & Ziakopoulos, A. (2022). Smart Roads and Transport Infrastructure. In: Digitalization For Sustainable Infrastructure: The road ahead. Edited by C. Secchi and A. Gili. ISPI's Centre on Infrastructure (Chapter 7).
[70] UK Department for Transport (DfT), Smart Motorway Safety: Evidence Stocktake and Action Plan, 2020. https://assets.publishing.service.gov.uk/media/5fb67beae90e0720906df981/smart-motorway-safety-evidence-stocktake-and-action-plan.pdf

2.3.3.2. Smart Intersections

Several AI frameworks have been proposed for smart intersection analysis. An example is the **Intersection Traffic Safety Framework (ITSF)**, which utilizes V2I communications and ML to identify and mitigate collision risks at intersections. These systems can achieve high accuracy in classifying high-risk vehicles, while their performance is influenced by range, latency, the number of vehicles in the network as well as percentage of drivers that ignore warnings. Under the condition that a considerable penetration rate is achieved in vehicle fleets so that more than 60% of vehicles feature V2I communications, simulation results indicate that collision rates will be significantly reduced, reaching reductions of up to 100%, even when some drivers ignore warnings[71]. However, it should be noted that these results are still simulated, while field trials will need to be conducted to confirm them empirically.

Real-time analysis of video image feeds from interventions has been a topic under examination in recent years. Recently, it has been achieved without transmission of raw video information, which protects detected road user privacy. This has been rendered possible in studies testing the feasibility of integrating two cameras (one at the street-level and one at bird's eye view), both viewing an intersection in a testbed in New York City, along with a programmable edge computing node. This system can enable real-time analysis and decision-making for traffic safety applications without compromising road user privacy[72].

It is important to note that the increased interconnectivity of the system causes new effects to emerge, but also to come under the more direct control of the transport authorities. Specifically, distinct **signal priority strategies (SPS)** have different impacts on emissions from affected vehicles. To provide evidence, a real-world intersection in China was simulated under three different SPSs: an active strategy, a real-time strategy and an Intelligent Vehicle Infrastructure Cooperation System (i-VICS) based strategy. The active strategy optimized a unified bus priority protocol by predicting vehicle counts and total clearance time. The real-time strategy dynamically allocated the green time of each phase under real-time traffic flow conditions and concurrently considered the bus priority. Lastly, i-VICS combined the information of vehicles, pedestrians, and roads to increase traffic efficiency. It incorporated real-time traffic information over a broader area, more detailed vehicle identification data, and an intelligent speed recommendation strategy. Based on simulation results, the i-VICS SPS reduced overall emissions by over 28% in the smart intersection case study[73].

Additional applications in smart intersections, which are now at a conceptual stage, can help save lives directly and indirectly on the roads. One such example is **Emergency Vehicle Preemption (EVP)**. EVP aims to grant right of way to emergency vehicles as they rush to an incident by coordinating a green wave through a network of signalized intersections. When the origin and destination of each emergency vehicle is determined, a signal is transmitted to every intersection with enough time to clear it as the vehicle approaches. In simulation tests, smart EVP systems have been shown to facilitate emergency vehicle passage by minimizing its travel time, while the impacts in the overall traffic in the proximity in terms of number of stops, delays and travel time are minimized[74].

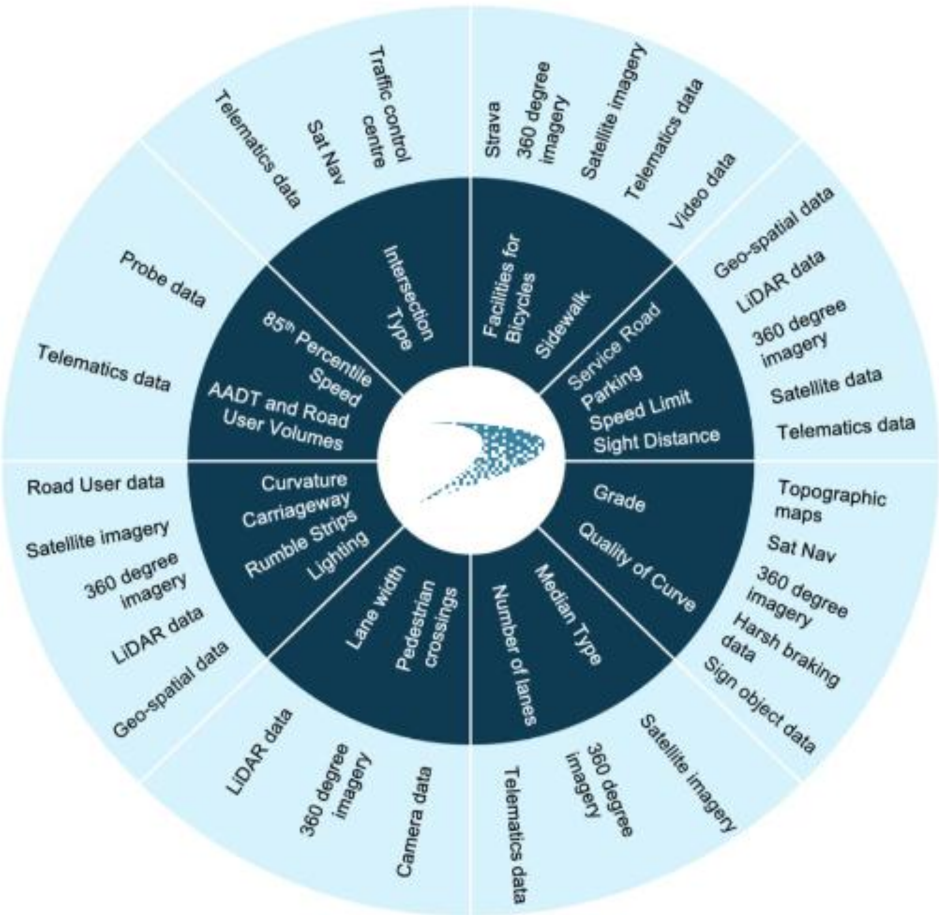
---

[71] Shahriar, M. S., Kale, A. K., & Chang, K. (2023). Enhancing intersection traffic safety utilizing V2I communications: Design and evaluation of machine learning based framework. IEEE Access, 11, 106024-106036.
[72] Ghasemi, M., Kleisarchaki, S., Calmant, T., Lu, J., Ojha, S., Kostic, Z., ... & Ghaderi, J. (2023, March). Real-time Multi-Camera Analytics for Traffic Information Extraction and Visualization. In 2023 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops) (pp. 288-290). IEEE.
[73] Liu, H., Zhang, Y., & Zhang, K. (2020). Evaluating impacts of intelligent transit priority on intersection energy and emissions. Transportation Research Part D: Transport and Environment, 86, 102416.
[74] Shaaban, K., Khan, M. A., Hamila, R., & Ghanim, M. (2019). A strategy for emergency vehicle preemption and route selection. Arabian Journal for Science and Engineering, 44, 8905-8913.

2.3.3.3. Ai-RAP – International Road Assessment programme

Another noteworthy instance of Intelligent Infrastructure applications is the AiRAP initiative. Launched by iRAP (the **International Road Assessment Programme**) during 2019, this initiative aims to enhance global access to and use of both existing and emerging data sources, including those enabled by AI & machine learning, computer vision systems, LIDAR, telematics, and more. AiRAP stands for "accelerated and intelligent" data collection, focusing on road safety-related information through automated, repeatable, and scalable approaches. These methods are designed to support safety assessments, crash risk mapping, and prioritization of investments for all types of road users. To facilitate consistency and more seamless operations, iRAP has established AiRAP accreditation, which verifies that collected data align with iRAP global standards. These standards are already widely adopted for recording road features that influence safety, helping to streamline evaluations and benchmark performance worldwide, and alleviating the need for complex data processing and storage for the data consumers[75]. AiRAP has the capacity to integrate a wide range of data, incorporating the aforementioned variety of sources for each road safety or infrastructure element, as shown in Figure 2.13.

Figure 2.13: AiRAP Data Sources for Various Road Safety Elements



Source: iRAP[76]

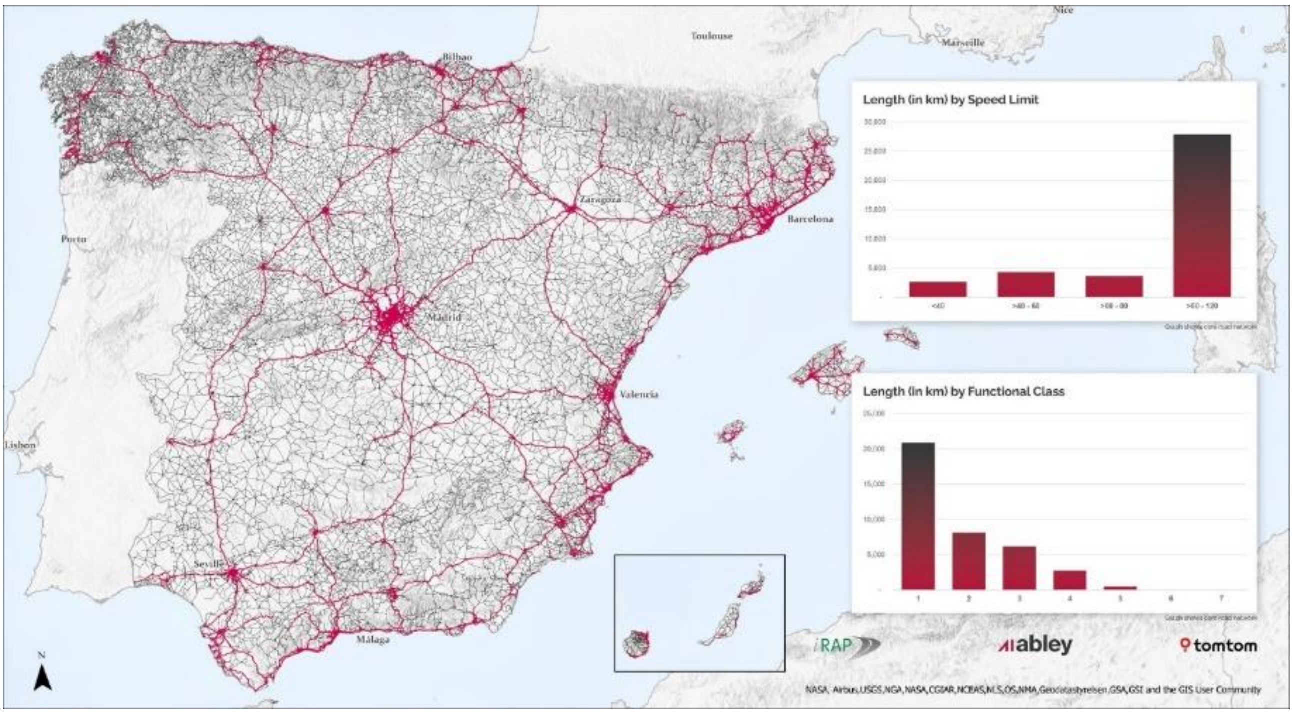
There have been several R&D initiatives involving AiRAP with case studies in the US, the UK, Australia, Vietnam, Brazil, Kenya and Ethiopia. A strategic goal of iRAP involves ensuring that 75% of travel for each road user is

---

[75] iRAP: The AiRAP initiative: https://irap.org/project/ai-rap/
[76] iRAP: Process for AiRAP attribute accreditation: https://resources.irap.org/Key-documents/AiRAP_Attribute_Accred_Process.pdf

on 3-star or better roads by the end of 2030, based on the assessment ratings. In turn, AiRAP has been used to determine where the majority of vehicle travel occurs, in an effort to provide more targeted countermeasures. An example of road network assessments is shown in Figure 2.14 for Spain, where 75% of total kilometers traveled occurs on just 7.4% of the road network [77,78].

Figure 2.14: AiRAP Road Network Assessments in Spain



Source: iRAP

Therefore, it is estimated that upgrading only 1–2% of the global road network each year through 2030 could achieve the UN Target of ensuring that at least 75% of travel takes place on roads rated 3-star or better for all users. This effort has been reported to have the potential to save over 400,000 lives annually and prevent more than 300 million deaths and injuries over the lifespan of the implemented improvements. Beyond the substantial reduction in road trauma, the initiative has been claimed to be highly cost-effective, generating over $8 in benefits for every $1 invested.

2.3.4. REAL-TIME EMERGENCY RESPONSE AND INCIDENT REPORTING

Emergency response optimization represents a critical application of AI in reducing post-crash fatalities through automated incident detection, intelligent dispatch, and optimal routing capabilities. Within the EU, since 31 March 2018, a **112-based eCall in-vehicle system** is mandatory on all new types of M1 and N1 vehicles (passenger cars and light duty vehicles)[79].

The eCall system is designed to automatically alert emergency services in the event of a motor vehicle crash, aiming to reduce response times and improve outcomes. However, its implementation remains limited, with

[77] iRAP-Abley: Sample Maps for Network Analysis: Spain: https://abley.com/en-us/75-samplemaps#Spain
[78] AiRAP big data partnerships help ensure 75% of travel is on 3-star or better roads for all road users by 2030: https://irap.org/2025/02/airap-big-data-partnerships-help-ensure-75-of-travel-is-on-3-star-or-better-roads-for-all-road-users-by-2030/
[79] The interoperable EU-wide eCall: https://ec.europa.eu/transport/themes/its/road/action_plan/ecall_en

only a few commercial applications currently in operation. Several studies have assessed the potential benefits of eCall using ad-hoc crash data analyses. These studies consistently estimate that eCall could reduce fatalities by approximately 1% to 15%, depending on crash type, location, and severity. The consistent findings across various international studies suggest that these potential benefits are likely transferable across regions[80].

In addition, an array of commercially available applications has been developed or have been enhanced with safety features. Some of these safety features include the **live reporting of crashes and casualties** on the network as they are encountered, the creation of weather and safety announcements, alerts on road condition and traffic updates, location tracking, augmented reality linkages and connections with car infotainment displays[81]. These data have the potential of further exploitation and analyses for real-time safety level assessments and response planning.

2.3.5. IMPLEMENTATION CHALLENGES

First and foremost, **data privacy** represents one of the most significant challenges in deploying comprehensive road safety AI systems, as these technologies often require extensive personal data collection from vehicles, mobile devices, and infrastructure sensors to function effectively. The European Data Protection Board highlights the tension between safety applications and **General Data Protection Regulation (GDPR) compliance**. Specifically, the data protection implications within the context of C-ITS are particularly complex, involving unprecedented volumes of location data, continuous broadcasting of personal information, and the exchange of data between vehicles and road infrastructure. Due to the novelty and sensitivity of these issues, discussions are still ongoing at the European level. As a result, the processing of personal data in C-ITS scenarios fall outside the scope of current data protection guidelines[82]. Nonetheless, advances in Federated machine Learning (FL) and edge computing allow for the undertaking and execution of calculations, decentralizing data processing and allowing vehicles to train local models without sharing raw data[83]. These developments, if proliferated, open new venues towards solving the data privacy challenge.

The implementation of AI systems in road safety also faces significant challenges related to **prediction accuracy**, primarily stemming from data quality, model complexity, and the inherent risks associated with advanced AI technologies. These challenges can hinder the effectiveness of AI applications in enhancing road safety and traffic management. Studies indicate that data containing errors and fluctuations can severely impact prediction outcomes, while exponential growth of traffic complicates the development of reliable predictive models, as existing models often struggle to process and analyze this vast amount of information effectively[84]. In even more recent developments, the transition to Artificial General Intelligence (AGI) in road transport systems introduces numerous risks, including mismanagement and loss of human control, which could adversely affect safety and efficiency[85].

---

[80] Thomson, R. (2017), E-Call (Automatic Crash Notification), European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu
[81] SafetyCulture: The 6 Best Road Safety Apps of 2025. https://safetyculture.com/
[82] European Data Protection Board "Guidelines 01/2020 on Processing Personal Data in the Context of Connected Vehicles". Available: https://www.edpb.europa.eu/our-work-tools/our-documents/guidelines/guidelines-012020-processing-personal-data-context_en
[83] Alqubaysi, T., Al Asmari, A. F., Alanazi, F., Almutairi, A., & Armghan, A. (2025). Federated Learning-Based Predictive Traffic Management Using a Contained Privacy-Preserving Scheme for Autonomous Vehicles. Sensors (Basel, Switzerland), 25(4), 1116.
[84] Govindaraju, S., Indirani, M., Maidin, S. S., & Wei, J. (2024). Intelligent Transportation System's Machine Learning-Based Traffic Prediction. Journal of Applied Data Sciences, 5(4), 1826-1837.
[85] McLean, S., King, B. J., Thompson, J., Carden, T., Stanton, N. A., Baber, C., ... & Salmon, P. M. (2023). Forecasting emergent risks in advanced AI systems: an analysis of a future road transport management system. Ergonomics, 66(11), 1750-1767.

System reliability in AI-powered road safety applications presents constant and critical engineering and validation challenges, as these systems must operate with exceptional accuracy across highly variable and unpredictable real-world conditions where failures can have direct and indirect safety implications. Apart from the ordinary and expected environmental challenges AI systems face, their reliability is also tested by acts such as "adversarial examples", which can have corruptive, exploitative or malicious intent, such as **cybersecurity** assaults, with the example of tampered road signs[86]. In a general response, the European Union Agency for Cybersecurity (ENISA) has identified reliability concerns as the primary barrier to wider deployment of AI safety systems, noting that a holistic AI lifecycle approach must be implemented as standard, while the various AI components and elements of the supply chain should be internal to the EU[87].

Infrastructure costs for implementing comprehensive AI and big data solutions for road safety represent a significant economic challenge, requiring substantial capital investments in sensors, computing systems, communications infrastructure, and ongoing maintenance across large geographic areas. However, in smart motorways, this is seen at present as an investment with interesting compound annual growth rates (CAGRs), as in both the hardware and software pillars of smart motorways CAGRs are considerable[88].

Connectivity requirements for advanced road safety systems present significant technical and infrastructure challenges as many safety-critical applications require continuous, low-latency, high-bandwidth data transmission between vehicles, infrastructure, and central processing systems. These limitations are shared with the limitations facing V2X infrastructure, which might affect CAV rollout. Achieving robust smart infrastructure and V2X communication protocols requires widespread deployment of roadside units (RSUs), high-speed 5G or upcoming 6G networks, and advanced edge computing infrastructures that reduce latency by processing data closer to the source[89]. However, the rollout of these technologies faces significant financial, logistical, and regulatory hurdles, particularly in rural or underserved areas where digital infrastructure may be limited.

2.4. DRIVER TELEMATICS

2.4.1. INSURANCE TELEMATICS

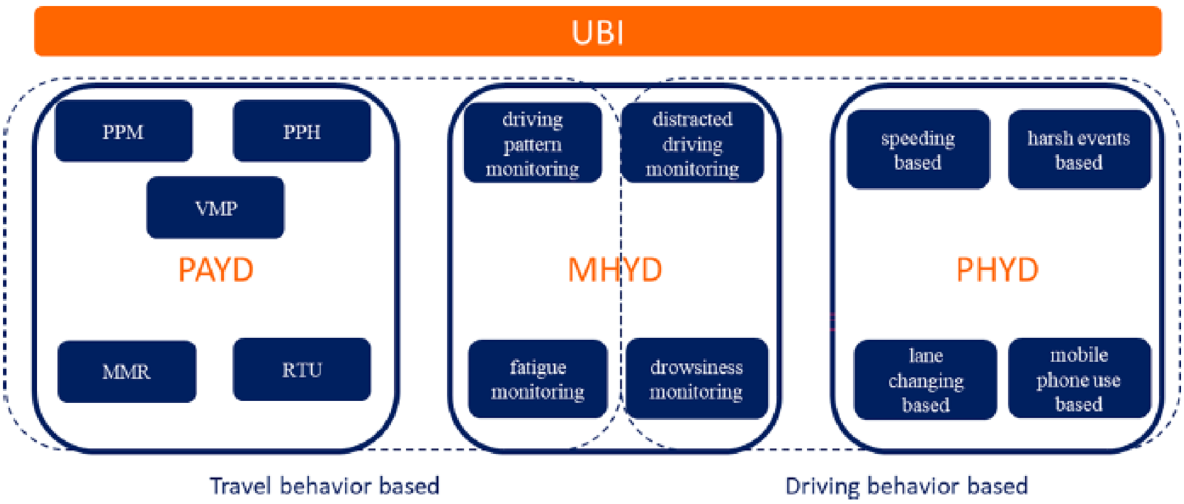
Telematics has emerged as a major focus in the auto and motor insurance industry, especially in light of ongoing road safety concerns and rapid technological advancements. In response, insurance providers have begun implementing **Usage-Based Insurance (UBI) models**, which leverage telematics data to tailor insurance rates based on actual driving behavior. Unlike traditional pricing models that primarily consider factors such as vehicle type or years of driving experience, UBI schemes assess individual risk more dynamically. The three main types of UBI are Pay-As-You-Drive (PAYD), Pay-How-You-Drive (PHYD), and Manage-How-You-Drive (MHYD). These models represent a significant shift in the insurance landscape, as they align premiums more closely with the real-world driving habits of the insured party.

[86] Camouflaged Graffiti on Road Signs Can Fool Machine Learning Models https://thenewstack.io/camouflaged-graffiti-road-signs-can-fool-machine-learning-models/
[87] ENISA: Artificial Intelligence – Cybersecurity Challenges. https://www.enisa.europa.eu/publications/artificial-intelligence-cybersecurity-challenges
[88] Global Smart Highway Industry Report 2022-2023 and 2024-2030: Artificial Intelligence Makes Big Inroads into Smart Highways: https://www.researchandmarkets.com/r/sxfd3m
[89] ETSI, E. (2020). 302 636-4-1 V1. 4.1; Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical Addressing and Forwarding for Point-to-Point and Point-to-Multipoint Communications; Sub-Part 1: Media-Independent Functionality. European Telecommunications Standards Institute: Sophia Antipolis, France.

Beyond financial customization, UBI schemes offer broader societal benefits. By **incentivizing safer and more efficient driving behavior**, these programs contribute to long-term reductions in traffic crashes and fatalities. Additionally, they support environmental goals by promoting fuel-efficient driving, which in turn leads to lower vehicle emissions. Figure 2.15 provides a visual representation of the three UBI models, highlighting the conceptual overlap among them. Despite their differences in focus, which can be mileage, behavior, or driver engagement, all three share a common goal of improving road safety and sustainability through more personalized, data-driven insurance practices. Typically, telematics systems feature the following characteristics in some form[90]:

- A software platform for managing fleet communications
- A Global Positioning System (GPS)-enabled device for real-time vehicle location tracking
- An interface connecting to the vehicle's engine for diagnostics and data retrieval
- An input/output module for linking external sensors or controls
- A SIM card for mobile network connectivity
- An accelerometer to detect motion, (harsh) acceleration, or sudden impacts
- An alert system for notifications or warnings

Figure 2.15: Overview of the Available UBI Schemes



Source: Ziakopoulos et al., 2022[91]

2.4.2. FLEET MANAGEMENT TELEMATICS

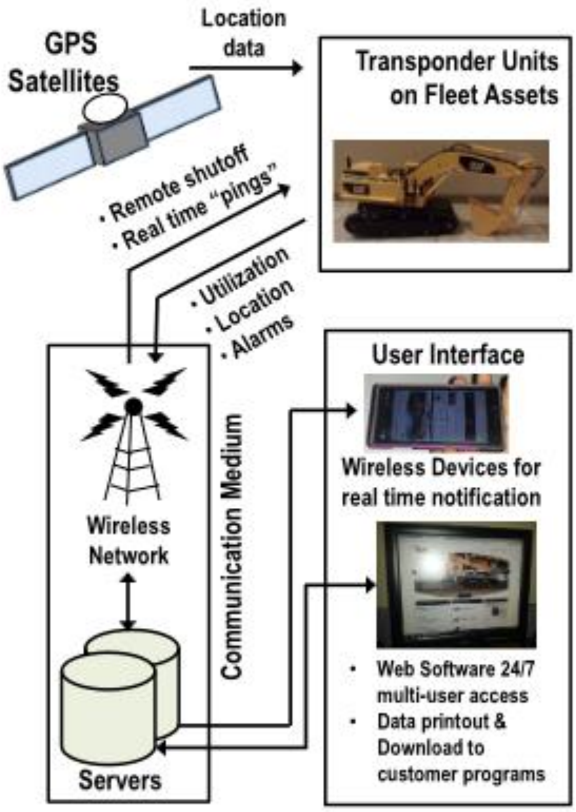
Fleet management telematics applications leverage advanced technologies to monitor, analyze, and optimize vehicle operations in real-time. These systems typically integrate GPS tracking, engine diagnostics, driver behavior monitoring, and wireless communication to provide a comprehensive overview of fleet performance. Typically used in commercial fleets, large-scale vehicle data are exploited to provide **higher route efficiency,**

[90] Business News Daily: What Is Telematics?: https://www.businessnewsdaily.com/16102-telematics.html

[91] Ziakopoulos, A., Petraki, V., Kontaxi, A., & Yannis, G. (2022). The transformation of the insurance industry and road safety by driver safety behaviour telematics. Case studies on transport policy, 10(4), 2271-2279.

reduce fuel consumption and improve maintenance scheduling[92]. An example of fleet telematics system components and data flow are shown in Figure 2.16.

Figure 2.16: Telematics System Components and Data Flow



Source: Said et al. (2016)[98]

2.4.3. ROAD SAFETY IMPACTS

Beyond insurance, telematics has also unlocked new avenues for road safety research by offering access to **detailed vehicle trajectory data and surrogate safety measures**, such as vehicle headways, harsh brakings and harsh accelerations. The latter of which constitute data that would otherwise be difficult or impossible to collect. A particularly impactful aspect of telematics is the ability to provide post-trip and, in certain cases, real-time **feedback to drivers**, a feature shown to encourage safer driving practices.

A comprehensive overview of technological developments in road safety telematics has quantified the effects of telematics applications on road safety outcomes, providing several key insights into how telematics influence driver behavior and safety performance[91]. Specifically:

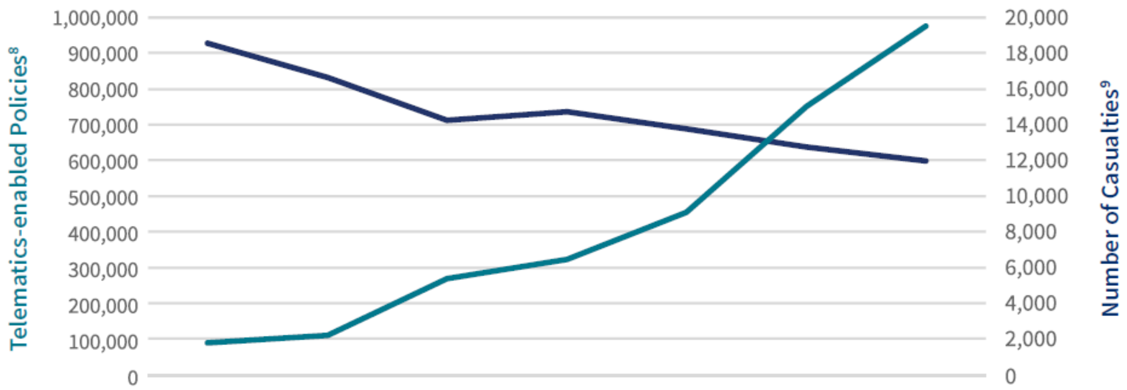
- 7 studies determined road crash reductions varying from 20 % to 43 %.
- 3 studies determined crash risk reductions varying from 37 % to 50 %.
- 7 studies determined speeding incident reductions varying from 15 % to 80 %.

[92] Szcześniak, J., & Gorzelańczyk, P. (2024). Analysis of the use of logistics-telematics systems for cost reduction in a transport company. Journal of Sustainable Development of Transport and Logistics, 9.

- 6 studies determined harsh event reductions varying from 10 % to 52 %.

Comparable or even more optimistic results are echo by industrial implementations, such as in the deployment of Securitas Belgium, where a 49% crash reduction was reported during 2012-2021 for trips conducted within Belgium[93]. In the UK, correlations have been observed between telematics adoption in insurance schemes and car casualty at the younger age group, ranging at 17-19 years old, as shown in Figure 2.17.

Figure 2.17: Telematics Adoption vs Car Casualties (17-19 years old)



	2011	2012	2013	2014	2015	2016	2017
Casualties	18,529	16,620	2,013	14,715	13,774	12,772	11,984
Adoption	90,000	110,000	269,000	323,000	455,000	750,000	975,000

Source: LexisNexis risk solutions[94]

Moreover, proposed policy recommendations across EU member states encourage the use of telematics in vehicle insurance by offering financial incentives and added benefits to drivers. One suggestion is the introduction of a "Safe Pass" Voucher, awarded to individuals who purchase a telematics-based insurance policy. To underline the feasibility of such policies, relevant social Cost-Benefit Analyses (CBAs) were conducted, with the conclusion of significant reduction in road injuries and fatalities and a significant environmental benefit across all considered scenarios. In particular, positive Net-Present Values (NPVs) and high Internal Rates of Return (5% < IRR < 53%) were calculated, lending credence to the socio-economic feasibility of the policy recommendation in the case study of Greece[95].

The aforementioned safety benefits, offered to private/individual vehicles, also apply to commercial fleet telematics, **enhancing the road safety levels of their daily fleet operations**. Recent developments involve the integration of predictive analytics and AI further supports proactive decision-making, cost savings, and regulatory compliance. Indicatively, fleet telematics software installed in 4,300 vehicles of a fleet in the security industry has been reported to reduce time spent at garages by 5%, time spent at suppliers by 11%

[93] Fleet Europe, Connected Fleets Conference: https://www.fleeteurope.com/en/connected/europe/features/successful-implementation-telematics-improved-driver-safety-72?t%5B0%5D=Connected%20Fleets%20Conference&curl=1

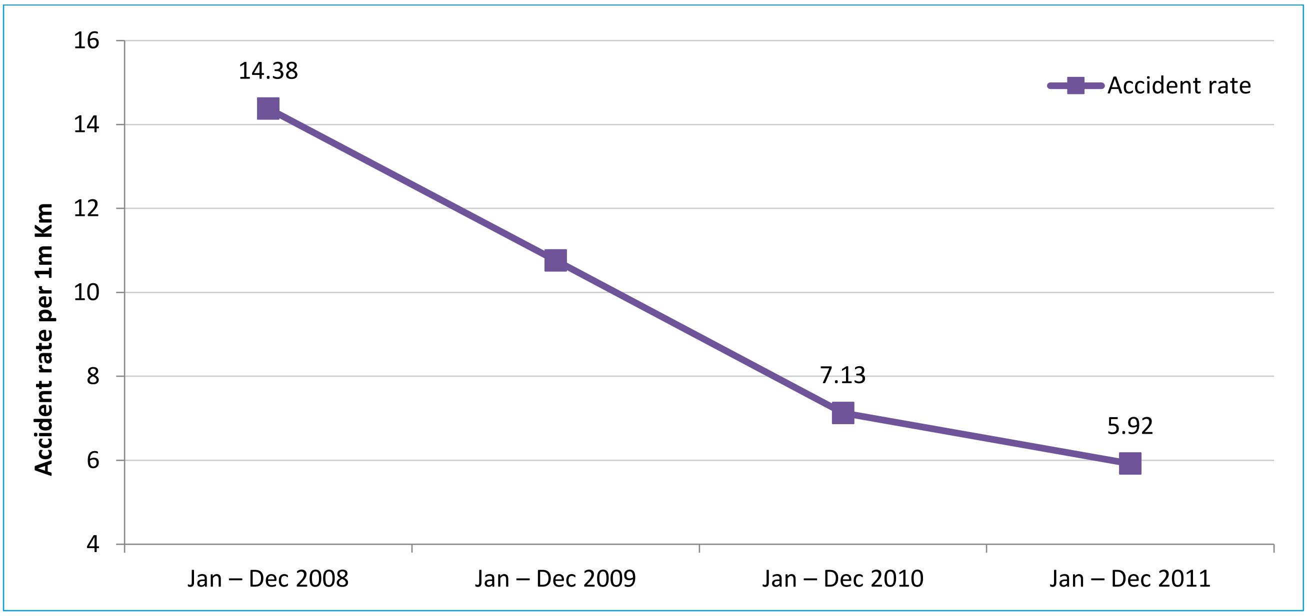
[94] LexisNexis risk solutions, The Societal Benefits of Telematics, White Paper, November 2018 www.risk.lexisnexis.co.uk/insurance/telematics

[95] Petraki, V., Ziakopoulos, A., Fragkiadaki, E., Karouzakis, N., Kakavoulis, K., & Yannis, G. (2024). Providing State-Supported Financial Incentives and Benefits for Vehicle Insurance Policies Using Telematics. In Strengthening European Mobility Policy: Governance Recommendations from Innovative Interdisciplinary Collaborations (pp. 87-99). Cham: Springer Nature Switzerland.

and saving more than 325,000 productivity hours each year, especially when coupled with strategic uses of geofencing[96].

Another notable example is the successful deployment by Kenya Power & Lighting Company, where telematics significantly improved the related transport operations of a fleet of 349 vehicles by aiding in the recovery of lost equipment and enhancing overall resource utilization. A notable reduction of crash rates per km concurrent with this measure, as shown in Figure 2.18. Simultaneous improvements in fleet availability, operational costs and vehicle theft reductions were reported by that study as well[97].

Figure 2.18: Crash Rates per million km Travelled over Fleet Management Scheme Implementation



Source: Waiyaki & Brits, 2015

Fleet telematics have also been used successfully to support two other major management tasks, **namely fleet use assessment and equipment health monitoring**. The authors of a related US-based study developed a telematics-based equipment health-monitoring (T-EHM) framework which used telematics data, in order to create a proactive tool which would optimize maintenance tasks based on equipment failure probability. The system predicted failures with an error of about 5% for dozers (a sub-type of the examined heavy vehicles), and the viability of the system was acknowledged by managers of daily company operations[98].

[96] Element fleet: The impact of fleet telematics on operations & productivity: https://www.elementfleet.com/resources/blog/the-impact-of-fleet-telematics-on-operations--productivity
[97] Waiyaki, E. C., & Brits, A. (2015). Leveraging Telematics for Optimal Fleet Performance. International Journal of Business, 1(1).
[98] Said, H., Nicoletti, T., & Perez-Hernandez, P. (2016). Utilizing telematics data to support effective equipment fleet-management decisions: Utilization rate and hazard functions. Journal of Computing in Civil Engineering, 30(1), 04014122.

2.4.4. CHALLENGES & LIMITATIONS

Overall, it is clear that **telematics contribute positively to driver behavior and crash reduction**, although the extent of these benefits can vary. For insurers, the challenge lies in optimizing the monitoring process, choosing the right combination of sensors, the type and volume of data collected, and the most suitable analytical methods—while ensuring compliance with data protection regulations. This inevitably leads to a critical balance between creating scalable, transferable models and delivering highly individualized insurance solutions.

However, current systems predominantly rely on proprioceptive sensors, which record internal vehicle data, while exteroceptive sensors, namely those capturing external environmental data, offer significant untapped promises. Exteroceptive options, such as microphones, cameras, biometric devices, and ultrasonic sensors, could serve as more practical or efficient alternatives to some proprioceptive sensors[99].

Lastly, a significant portion of telematics schemes aim to alleviate the burden from the end-user, in an effort to increase their market penetration. However, smartphone-based schemes are considerably demanding in data storage, handling and analysis, and several sophisticated algorithms have to be employed for data filtering and quality control to ensure accurate data outputs. Therefore, newer data manipulation algorithms are a crucial prerequisite. Telematics schemes encounter similar GDPR challenges and obstacles as those found in Big Data and AI applications, requiring appropriate solutions.

[99] Ortiz, F. M., Sammarco, M., Costa, L. H. M., & Detyniecki, M. (2020). Vehicle telematics via exteroceptive sensors: A survey. arXiv preprint arXiv:2008.12632.

CHAPTER 3. REVIEW OF TECHNOLOGY READINESS KPIS

3.1. FACTORS AFFECTING OVERALL TECHNOLOGICAL READINESS

Based on international academic and industrial literature, the ability of a country to adopt and leverage new technologies depends on various factors, including technological expertise, access to innovation, cultural perspectives, economic conditions, and individual adaptability. These elements collectively shape how effectively a country integrates emerging technologies.

This chapter describes the factors influencing technological readiness, as well as an analysis of key performance indicators (KPIs) used for evaluating technological readiness both in general and specifically within the transport sector at the national level. The information provided in the present chapter is essential to inform and shape the development of the expert questionnaire for this project.

3.2. KPIS USED FOR COUNTRY-LEVEL TECHNOLOGICAL READINESS ASSESSMENTS

There are various indices implemented towards the assessment of the technological readiness of countries, utilizing a variety of KPIs across the pillars which were previously outlined. The general logic of each index is outlined below; specific country indicators are detailed in the next chapter.

3.2.1. NETWORK READINESS INDEX (NRI)

The NRI assesses a country's preparedness to leverage ICT for development and competitiveness. It is structured around four main pillars, each encompassing several sub-pillars and indicators[100].

a. **Technology**: Evaluates the adoption and use of ICT. Sub-pillars may include (i) Access, (ii) Content and (iii) Future Technologies.

b. **Assesses** the readiness and skills of individuals, businesses, and governments to utilize ICT. Sub-pillars may include (i) Individuals, (ii) Businesses and (iii) Governments

c. **Governance**: Examines the political and regulatory environment affecting ICT development. Sub-pillars may include (i) Trust, (ii) Regulation and (iii) Inclusion

d. **Impact**: Measures the economic and social impacts resulting from ICT usage. Sub-pillars may include (i) Economy, (ii) Quality of Life and (iii) Contribution to the UN Sustainable Development Goals (SDGs)

Each sub-pillar consists of several potential indicators that provide detailed insights into the country's network readiness.

3.2.2. GLOBAL INNOVATION INDEX (GII)

The GII evaluates the innovation capabilities and outcomes of countries. It is divided into two main components[101] .

[100] Network Readiness Index Team: https://networkreadinessindex.org/

[101] WIPO - Global Innovation Index: https://www.wipo.int/en/web/global-innovation-index

a. **Innovation Inputs**: These inputs reflect the factors that enable innovative activities. Pillars include (i) Institutions, (ii) Human Capital and Research, (iii) Infrastructure, (iv) Market Sophistication and (v) Business Sophistication

b. **Innovation Outputs**: These outputs capture the results of innovative activities within the economy. Pillars include (i) Knowledge and Technology Outputs and (ii) Creative Outputs

Each pillar comprises multiple indicators that collectively provide a comprehensive view of a country's innovative ecosystem.

3.2.3. DIGITAL ACCESSIBILITY RIGHTS EVALUATION (DARE) INDEX

The DARE Index measures a country's commitment to digital accessibility for people with disabilities. It focuses on three primary dimensions[102]:

a. **Legal Frameworks**: Assesses the existence and effectiveness of laws and policies promoting digital accessibility.

b. **Capacity to Implement**: Evaluates the resources and infrastructure available to enforce digital accessibility measures.

c. **Actual Implementation**: Examines the real-world application and enforcement of digital accessibility standards and practices.

These dimensions are analyzed through various indicators that reflect the country's progress in ensuring inclusive digital environments.

3.2.4. EU TECHNOLOGY READINESS LEVELS (TRL)

The **Technology Readiness Level (TRL)** scale was originally defined by NASA in the 1990s[103] as a means for measuring or indicating the maturity of a given technology. The TRL spans over nine levels as follows:

- TRL 1 – Basic principles observed
- TRL 2 – Technology concept formulated
- TRL 3 – Experimental proof of concept
- TRL 4 – Technology validated in lab
- TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)

[102] G3ict - Digital Accessibility Rights Evaluation Index: https://g3ict.org/digital-accessibility-rights-evaluation-index/

[103] NASA - Technology Readiness Levels: https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/

- TRL 7 – System prototype demonstration in operational environment
- TRL 8 – System complete and qualified
- TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)

The EC, mainly through the Horizon Europe research programme, has selected the TRL scale as an indicator to better position a project in the work program. TRL, as a unified scale, enables to align a project / technology under development with the expectations of the EC in this context. For example: a higher requested TRL clearly means that the EC is looking for a more applicative solution in the scope of the project. Alternatively, a lower requested TRL indicates an expectation for a more basic research project.

Another use of the TRL is an indication of the 'entry point' of a technology application. This refers to the maturity level of the given technology/product/process at the beginning of the project / implementation. In this case, a given TRL serves as a 'lower boundary'.

3.3. KPIS OF TRANSPORT AND ROAD SAFETY TECHNOLOGICAL READINESS

As technological advancements progress rapidly, several specific technologies emerge, which were reviewed in Chapter 2 of the present report. Specific KPI approaches which monitor the adoption of the above listed (or similar) merit particular investigation, as they are better suited within the transport-oriented context of the present report, drawing from sources of academic or industrial research.

3.3.1. KPIS FOR TECHNOLOGICAL READINESS IN THE FIELD OF CAV/AV/ADAS

Within industrial research, the **Autonomous Vehicles Readiness Index (AVRI)** has been proposed as a KPI investigated in 25 countries[104]. Based on this approach, AVRI is organized into four pillars, containing 25 variables in total. The variables mainly relied on publicly available information, including media reports, press releases and other material. To complement those, a consumer survey was carried out. The variables within each of the four pillars were combined to generate an aggregate score. As a result, the highest-ranked country received a score of one, while the lowest-ranked country received zero.

The breakdown of the four pillars and 25 variables utilized in AVRI calculation is as follows (measurement in parentheses):

a. **Policy & Legislation**
   - AV regulations and policies (Existence of national AV regulations; binary: 1 = Yes, 0 = No)
   - Government-funded AV pilots (Number of national AV pilot programs; count)
   - AV-focused cyber security policies (Existence of cyber policies for AVs; binary: 1 = Yes, 0 = No)
   - Data-sharing policies for AVs (Existence of national policies on AV data sharing; binary: 1 = Yes, 0 = No)

b. **Technology & Innovation**
   - AV-related investments (Total AV-related private and public investments; USD, millions)

[104] KPMG (2019). 2019 Autonomous Vehicles Readiness Index. Assessing countries' preparedness for autonomous vehicles. KPMG International.

- Number of AV patents filed (Total AV-related patents granted, count)
- Availability of high-tech talent (Number of AI, robotics, and engineering graduates per year; count)
- AV-specific research output (Number of AV-related research papers published, count)

c. **Infrastructure**
- Quality of roads (Global Competitiveness Index Road quality score; scale: 1-7)
- 4G/5G network coverage (Percentage of national area covered; %)
- Urban density (Population density in major urban areas; people per km²)
- EV charging stations (Number of public electric vehicle charging stations per 100 km of road; count/100 km)

d. **Consumer Acceptance**
- Ride-sharing adoption (Percentage of population using ride-sharing services; %)
- Public trust in AVs (Survey results on willingness to use AVs; % positive responses)
- Media sentiment on AVs (Share of positive AV-related news coverage; % positive articles)

Regarding AVs, also termed 'self-driving cars', relative research has been conducted by the EC's Joint Research Centre (JRC), within a wider report aiming to evaluate the readiness levels of AI technologies and predict their potential impact and timeline for real-world applications. The frequently adopted by the **EU, Technology Readiness Levels (TRL)** scale, was used to determine the maturity of a particular technology. The scale assumes values from 1 to 9, with 1 being the lowest (basic principles observed) and 9 the highest (actual system proven in operational environment). Readiness-vs-Generality charts were also used to plot AI technologies based on their maturity (readiness) against their scope (generality). The methodology suggests that technologies with narrower applications tend to achieve higher readiness levels, while more general AI capabilities remain less mature. This was evident for CAVs, as they have received relatively high TRL ratings until Level 3 (which denotes semi-autonomy), while higher autonomy levels (Level 4 & 5) remain at the proof-of-concept level[105].

The **OECD** has also investigated the topic, producing a report which examined the necessary adaptations in infrastructure to support the integration of AVs. The report focused on three key policy areas:[106]

a. **Physical Infrastructure:**
   i). Road Design and Maintenance: Emphasizes the need for clear lane markings, consistent signage, and well-maintained roads to ensure AVs can navigate effectively.
   ii). Traffic Management: Discusses updating traffic control systems to accommodate AV behaviors and interactions with human-driven vehicles.

b. **Data and Digital Infrastructure:**
   i). High-Definition Mapping: Highlights the importance of accurate, up-to-date maps for AV navigation and decision-making.

[105] Martinez-Plumed, F., Gomez Gutierrez, E. and Hernández-Orallo, J., AI Watch: Assessing Technology Readiness Levels for Artificial Intelligence, EUR 30401 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-22987-2, doi:10.2760/15025, JRC122014.
[106] ITF (2023), Preparing Infrastructure for Automated Vehicles, ITF Research Report, OECD Publishing, Paris. Available: https://doi.org/10.1787/b96ca198-en

ii). Communication Systems: Explores the development of Vehicle-to-Infrastructure (V2I) communication to relay real-time information between AVs and traffic management centers.

c. **Institutional Frameworks:**
   i). Regulatory Adaptation: Addresses the need for updating traffic laws and vehicle regulations to incorporate AV operations.
   ii). Stakeholder Collaboration: Encourages cooperation between governments, industry players, and research institutions to facilitate AV integration.

3.3.2. KPIS FOR TECHNOLOGICAL READINESS IN THE FIELD OF EVS

Technological readiness in the EV sector involves assessing the capabilities of the infrastructure, battery technology, vehicle performance, and overall ecosystem to ensure that EVs are efficiently integrated into transportation systems. To evaluate technological readiness, key performance indicators (KPIs) can focus on various factors like charging infrastructure, battery efficiency, adoption rates, and the ability to scale manufacturing. Below are specific KPIs that are useful for measuring technological readiness in the field of electric vehicles.

a. **EV Battery Efficiency and Range**: This KPI measures the energy density, lifespan, and efficiency of EV batteries, which determines how far an EV can travel on a single charge. A higher energy density and a longer battery lifespan are crucial for ensuring EVs are practical for everyday use.
b. **Charging Infrastructure Availability**: This KPI measures the number of charging stations available per geographical area and their distribution across key locations (urban, suburban, highways). For instance, a reasonable ratio (e.g. 1 charging station per 10 EVs) ensures that users can conveniently charge their vehicles.
c. **Charging Speed**: This KPI evaluates the charging time at different levels, such as slow (Level 1), fast (Level 2), and ultra-fast (DC fast charging). Practical limitations have to be considered with this KPI, as it has been shown that higher charging electric currents lead to a rapid charge of the batteries but degrades EV battery life[107].
d. **EV Adoption Rate**: This KPI tracks the growth of EV sales and market share relative to traditional internal combustion engine (ICE) vehicles. A considerable growth rate in EV adoption (e.g. 10% annually) could indicate technological readiness in the sense that consumer demand is aligned with the availability of EVs and charging infrastructure[108].
e. **Manufacturing Scalability**: This KPI assesses how well EV manufacturers are scaling production in response to market needs. The ability to produce tens of thousands of EVs annually with minimal supply chain disruptions and high quality is an indicator of technological readiness and capacity for large-scale adoption[109].
f. **Cost Parity with ICE Vehicles**: This KPI measures the total cost of ownership (TCO) of EVs in relation to ICE vehicles, considering factors like purchase price, maintenance, and fuel savings. When EVs reach

[107] Choi, J. W., & Aurbach, D. (2016). Promise and reality of post-lithium-ion batteries with high energy densities. Nature reviews materials, 1(4), 1-16.
[108] Qadir, S. A., Ahmad, F., Al-Wahedi, A. M. A., Iqbal, A., & Ali, A. (2024). Navigating the complex realities of electric vehicle adoption: A comprehensive study of government strategies, policies, and incentives. Energy Strategy Reviews, 53, 101379.
[109] Li, H., Li, H., Lai, Y., Yang, Z., Yang, Q., Liu, Y., ... & Guo, X. (2022). Revisiting the preparation progress of nano-structured Si anodes toward industrial application from the perspective of cost and scalability. Advanced Energy Materials, 12(7), 2102181.

cost parity with ICE vehicles (with a lower TCO after a few years), they become more accessible to a broader market.

g. **Battery Recycling and Second-Life Use**: This KPI measures the effectiveness of recycling programs and second-life use of batteries. The percentage of EV batteries recycled or repurposed for energy storage systems could be a strong indicator of how well the industry is preparing for sustainable battery lifecycle management.

h. **EV Performance and Consumer Satisfaction**: This KPI tracks customer satisfaction scores based on factors such as ride comfort, responsiveness, and overall driving experience. A high consumer satisfaction score can indicate higher technological readiness, as it reflects how well EVs meet consumer expectations.

3.3.3. KPIS FOR TECHNOLOGICAL READINESS IN THE FIELD OF REAL-TIME TRAFFIC MANAGEMENT

Specific KPIs to measure technological readiness in real-time traffic management can be the following:

a) **System Uptime and Reliability**: Downtime or system failures can lead to delays in traffic monitoring, incident management, and optimization efforts. A high percentage of uptime is crucial to maintain continuous real-time traffic control[110]. For instance, a system with 99.9% uptime ensures that disruptions are minimized, allowing for reliable and seamless traffic management. High reliability is also critical for reducing the risk of crashes and improving traffic flow.

b) **Data Collection Coverage:** This KPI measures the extent of data coverage across a transportation network, such as the percentage of major roads equipped with real-time sensors. A network with high percentages of coverage ensures that the system has sufficient data to monitor traffic conditions, identify bottlenecks, and predict traffic flow, thereby enabling better management decisions.

c) **Real-Time Data Processing Latency:** This KPI measures how quickly the system can process incoming data and provide actionable insights to optimize traffic flow. A system with low processing latency ensures that decisions regarding signal adjustments or rerouting can be made almost instantly, which is essential during traffic incidents or high-traffic conditions. Reducing latency minimizes the time between data collection and actionable outcomes, leading to improved traffic flow and safety.

d) **Accuracy of Traffic Flow Predictions:** This KPI measures the accuracy of traffic flow predictions in real-time scenarios. A high prediction accuracy rate can ensure that the system effectively anticipates traffic congestion well in advance, enabling timely interventions that reduce congestion and improve traffic efficiency[111]. Accurate predictions are key to minimizing delays and enhancing the overall user experience.

e) **Communication System Efficiency:** This KPI measures the responsiveness and effectiveness of the communication network that supports the system. Communication delays or poor throughput can

[110] Tkhoruk, Y., Kucher, O., Holotiuk, M., Krystopchuk, M., & Tson, O. (2019). Modeling of assessment of reliability transport systems. Матеріали Міжнародної науково-технічної конференції „Актуальні проблеми транспорту “, 204-210.

[111] Sun, P., Aljeri, N., & Boukerche, A. (2020). Machine learning-based models for real-time traffic flow prediction in vehicular networks. IEEE Network, 34(3), 178-185.

hinder real-time decision-making[112],[113]. Conversely, good communication efficiency ensures that the system can promptly adjust signals and traffic flow in response to real-time changes. Efficient communication supports timely responses to traffic incidents and congestion.

f) **Incident Detection and Response Time:** This KPI measures the time it takes from detecting an incident (e.g., crashes or road blockages) to initiating a response (e.g., rerouting traffic or dispatching emergency response services). A good response time ensures that incidents are managed swiftly, minimizing disruptions to traffic flow. Faster responses can significantly reduce the impact of traffic incidents, leading to smoother traffic operations and enhanced safety for all road users[114].

g) **Integration with External Systems:** This KPI measures how well the traffic management system collaborates with other external systems to provide coordinated solutions. For example, integration with more than one major public transit system allows for better synchronization of traffic signals and public transportation schedules, optimizing traffic flow and improving the overall efficiency of the transportation network. Such systems might be considerably complex to harmonize[115].

h) **Energy Efficiency of Traffic Management Infrastructure:** This KPI measures the energy efficiency of infrastructure components such as traffic lights, sensors, and data centers. By optimizing energy usage, the system reduces operational costs and environmental impact. For instance, reducing energy consumption by a decent percentage per traffic light helps ensure the system remains sustainable over the long term[116], [117].

i) **Public Satisfaction and Adoption Rates**: This KPI measures how satisfied the public is with the system's functionality, ease of use, and effectiveness in managing traffic. For example, a high public satisfaction rate reflects positive feedback from users who find the system helpful in navigating traffic or receiving timely updates. High adoption rates indicate that the system is user-friendly and trusted, leading to greater public participation and more effective traffic management.

3.3.4. KPIS FOR TECHNOLOGICAL READINESS IN THE FIELD OF DRIVER TELEMATICS

The following Key Performance Indicators (KPIs) help measure the effectiveness and readiness of driver telematics systems:

a) **Data Collection Accuracy & Reliability**: This KPI measures the precision of data gathered from vehicle sensors, GPS, and other tracking systems. A high data accuracy rate ensures that driving patterns, speed, location, and fuel usage are correctly recorded, allowing for reliable analytics and decision-making.

[112] Minea, M. G., Bădescu, I. G., & Dumitrescu, S. D. (2011, October). Efficiency of multimodal real-time travel and traffic information services employing mobile communications. In 2011 10th International Conference on Telecommunication in Modern Satellite Cable and Broadcasting Services (TELSIKS) (Vol. 2, pp. 765-768). IEEE.
[113] Liu, J., Wan, J., Jia, D., Zeng, B., Li, D., Hsu, C. H., & Chen, H. (2017). High-efficiency urban traffic management in context-aware computing and 5G communication. IEEE Communications Magazine, 55(1), 34-40.
[114] Basheer Ahmed, M. I., Zaghdoud, R., Ahmed, M. S., Sendi, R., Alsharif, S., Alabdulkarim, J., ... & Krishnasamy, G. (2023). A real-time computer vision based approach to detection and classification of traffic incidents. Big data and cognitive computing, 7(1), 22.
[115] Lee, W. H., Tseng, S. S., & Shieh, W. Y. (2010). Collaborative real-time traffic information generation and sharing framework for the intelligent transportation system. Information Sciences, 180(1), 62-70.
[116] Shojafar, M., Cordeschi, N., & Baccarelli, E. (2016). Energy-efficient adaptive resource management for real-time vehicular cloud services. IEEE Transactions on Cloud computing, 7(1), 196-209.
[117] Ning, Z., Huang, J., & Wang, X. (2019). Vehicular fog computing: Enabling real-time traffic management for smart cities. IEEE Wireless Communications, 26(1), 87-93.

b) **Real-Time Data Transmission Latency**: This KPI measures the time delay between data collection and its availability for analysis (Hossain et al., 2010). It should be noted that this technology has high synergies with CAV adoption. Recent developments in AI processes based on edge computing have shown highly promising results.

c) **Driver Behavior Monitoring Effectiveness:** This KPI assesses how well a system detects behaviors like speeding, harsh breaking, and distracted driving. A high detection accuracy rate can help support the belief that telematics solutions provide actionable insights for fleet managers and insurance companies.

d) **Predictive Maintenance Accuracy**: This KPI can be used to evaluate how accurately the system predicts maintenance requirements (e.g. as a percentage)[118]. Higher prediction success rates minimize unexpected breakdowns and can help optimize vehicle servicing schedules.

e) **Cybersecurity and Data Protection Compliance: S**ince telematics involves sensitive vehicle and driver data, cybersecurity and compliance with regulations like GDPR (in the EU) or the equivalent (CCPA, in the US) are critical[119]. This KPI assesses system adherence to cybersecurity standards and regulations. A system that meets high or total compliance with global data privacy laws ensures secure data handling and user trust.

f) **Cost-Benefit Ratio of Telematics Implementation**: This KPI assesses the return on investment (ROI) for telematics adoption. A ROI ratio considerably higher than the baseline of 1.00 signifies a well-optimized system[120].

[118] Tichý, T., Brož, J., Bělinová, Z., & Kouba, P. (2020). Predictive diagnostics usage for telematic systems maintenance. In 2020 Smart City Symposium Prague (SCSP) (pp. 1-6). IEEE.
[119] Van Den Boom, F. (2020). Regulating telematics insurance. Van den Boom, F (2020) Regulating Telematics Insurance, in P. Marano and K. Noussia (Eds): Insurance Distribution Directive, AIDA Europe on Insurance Law and regulation, 3.
[120] Petraki, V., Ziakopoulos, A., Fragkiadaki, E., Karouzakis, N., Kakavoulis, K., & Yannis, G. (2024). Providing State-Supported Financial Incentives and Benefits for Vehicle Insurance Policies Using Telematics. In Strengthening European Mobility Policy: Governance Recommendations from Innovative Interdisciplinary Collaborations (pp. 87-99). Cham: Springer Nature Switzerland.

CHAPTER 4. TECHNOLOGY READINESS IN THE EAP REGION

4.1. QUESTIONNAIRE DEVELOPMENT

Based on the above state-of-the-art review, a **dedicated questionnaire** has been developed, in order to assess the technological readiness in the EaP region with respect to key road safety and sustainability technologies. The questionnaire comprised the following sections:

1. **General Technology Readiness**
2. **Vehicle Safety & Automation**
3. **Electric Vehicles & Sustainability**
4. **Big Data, Digitalization & AI Applications**
5. **Key road safety figures**
6. **Country experiences with advanced road safety and sustainability technologies**
7. **Technology acceptance & trust by country stakeholders**

The survey aimed to assess the technological readiness for road safety and sustainability related technologies in the EaP region, in order to highlight opportunities, challenges, and good practice examples. The survey was addressed (but not limited) to representatives of: Ministry of Transport, Ministry of Interior/ Traffic Police, Road Safety Lead Agency, Road Authorities / Road Operators, Road Safety academics in all of the countries. The complete questionnaire is available in Appendix 1.

4.2. ARMENIA

4.2.1. GENERAL TECHNOLOGY READINESS

4.2.1.1. Strategies, Programmes and Investments

Armenia has a national strategy for technology adoption and digital transformation. The government has adopted several strategic documents, including the "Digital Transformation Strategy 2021–2025"[121] and the "Armenia Digital Agenda – 2030", which set clear objectives for enhancing digital infrastructure, digital governance, public service transformation, and fostering innovation across the economy. These strategies are supported by dedicated institutions and ongoing reforms, and they aim to improve digital literacy, promote the use of advanced technologies, and support both public and private sector digitalization

Moreover, Armenia has a legal framework for technology adoption that covers key areas such as data privacy and inclusiveness:

- **Data Privacy**: Armenia's Law on Personal Data Protection (adopted in 2015, amended in 2018) regulates the collection, processing, and safeguarding of personal data by public and private entities. It aligns closely with international standards like the GDPR, ensures data subject rights (access,

[121] Armenia's Digital Transformation Strategy (2021-2025): https://dig.watch/resource/armenias-digital-transformation-strategy-2021-2025
https://www.primeminister.am/en/press-release/item/2020/07/20/Nikol-Pashinyan-meeting-Digitization/

rectification, erasure, objection, portability), and mandates security measures, consent, and breach notification. Enforcement is overseen by the Personal Data Protection Agency.

- **Inclusiveness and Tech Sector Support**: Recent laws, such as the 2025 Law on State Support for the High-Tech Sector, define and support high-tech and IT activities, aiming to foster innovation and inclusiveness through state support, tax privileges, and incentives for tech businesses.
- **Broader Digital Regulation**: Armenia is updating its legal framework for electronic communications to align with EU standards, further supporting digital transformation and inclusivity.

Armenia has both national and international investments and programs focused on transport and road safety technology. The country has received support for multiple major road safety and infrastructure projects, including the Armenia Road Safety Improvement Project (2019–2023) focused on improving accident-prone areas and enhancing road safety infrastructure. The Sisian-Kajaran road construction, part of the North-South Transport Corridor, incorporates climate-resilient and advanced road safety features to reduce accidents and improve connectivity. The North-South Road Corridor Investment Program aims to upgrade key road sections to improve safety and sustainability, including reconstruction and road asset management systems.

UNDP and UNICEF implemented a joint project funded by the United Nations Road Safety Fund (UNRSF) to reframe road safety in Armenia by connecting data, people, and policies. This project introduced innovative methodologies such as data analytics and digitalization to support the National Road Safety Strategy and reduce road fatalities by 2030.

At national level, the Armenian government has been investing in road infrastructure and safety improvements. Between 2018 and 2023, major repairs, reconstruction, and construction of over 1300 km of roads were carried out with state budget funds totaling approximately 182.8 billion AMD. In 2023 alone, 25 accident-prone "black spots" were eliminated and safety elements improved on 38.4 km of roads with international support.

Armenia’s national strategies include increasing public investment in the road system to 1% of GDP by 2025 and reducing road accidents caused by road malfunctions by up to 20% by 2026, as outlined in the Armenia Development Strategy and the Government’s 2021-2026 Action Plan.

In terms of human resources, Armenia produces approximately 20 to 30 university graduates per year in data science, artificial intelligence (AI), robotics, or closely related fields.

The American University of Armenia (AUA) offers a Bachelor of Science in Data Science (BSDS) program, which has been graduating cohorts since its launch. While exact yearly graduate numbers are not publicly detailed, the program is relatively small and selective, typically graduating around 15-25 students annually based on program scale and alumni reports. Other Armenian universities, including Yerevan State University and the National Polytechnic University of Armenia, offer courses and research opportunities in AI, machine learning, and robotics, contributing additional graduates in these fields, but specific graduate counts are not publicly available.

Armenia's "Generation AI" program[122], targeting high-school students, is building a pipeline for future AI talent but does not yet translate directly into university graduate numbers.

Moreover, Armenia produces approximately 50 to 70 university graduates per year in transportation engineering, road safety, or closely related fields based on available academic programs and student enrollment data. The National Polytechnic University of Armenia (NPUA), through its Institute of Mechanical Machine-Building, Transport Systems, and Design, offers bachelor's and master's degrees in specialties directly related to transportation engineering, such as:

- Transport machine-building
- Transport systems
- Mechanical engineering related to transport

Currently, the institute has about 622 students in total, with 533 bachelor students and 82 master students across all specialties, including transport-related ones. Transport-related programs graduate roughly 40-60 bachelor-level and 10-15 master-level students annually. Other institutions, such as the Armenian National University of Architecture and Construction and Yerevan State University, also produce graduates in infrastructure and civil engineering. However, data regarding the number of graduates specializing in transport or road safety is not specified. There is no standalone program in road safety engineering, but the subject is typically included within transport and civil engineering courses.
Each year, approximately 50 to 70 students graduate in transport engineering and related fields in Armenia, mainly from the National Polytechnic University of Armenia's transport and mechanical engineering programs.

4.2.1.2. Knowledge and Operational Capacity in Government and Transport / Road Operators

The Ministry of Territorial Administration and Infrastructure (MTAI), Ministry of Internal Affairs, and other agencies have adopted innovative data analytics platforms for real-time road crash and black spot analysis. These platforms, developed with UNDP's SDG Innovation Lab and funded by the UN Road Safety Fund, enable policymakers to make evidence-based decisions using big data and behavioral insights. This reflects a **growing operational capacity in managing road safety through technology**.

Key administrative figures such as the Deputy Minister of Territorial Administration and Infrastructure and the Deputy Minister of Internal Affairs demonstrate understanding and endorsement of data-driven and behavioral interventions. This suggests that **senior management has at least some exposure to innovation management and data science principles**, although detailed information on formal MSc or higher degrees in these fields among officials is not publicly available.

Projects supported by international organisations include training courses and seminars on road safety audits and advanced data collection/analytics to enhance local capacities. The institutional strengthening component of these projects aims to **equip on-the-ground personnel with technical skills** for improved data management and safety interventions.

[122] https://eufordigital.eu/armenias-generation-ai-programme-marks-a-successful-first-year/

Hands-On Experience with Technology has been promoted through pilot interventions, such as the one on the Yerevan-Proshyan highway, implemented based on insights from data analytics platforms. Behavioral interventions informed by data have engaged thousands of drivers, resulting in measurable improvements like an 18% reduction in speeding violations. This shows practical, operational use of road safety technologies and data-driven management in the field.

Armenia’s road safety strategy includes targets for reducing fatalities by 50% by 2030 and improving road safety infrastructure to meet international standards.

4.2.1.3. Collaborations Between Government, Industry and / or Academia

There are formal collaborations in place between government, industry, and academia in Armenia in the field of road safety technology, though these partnerships are still evolving and expanding.

The “Re-framing Road Safety in Armenia” project is a key example of multi-stakeholder collaboration involving the RA Ministry of Territorial Administration and Infrastructure, RA Police, UNDP’s SDG Innovation Lab, National Road Safety Council NGO, UNICEF, and the Swedish road safety consultancy SweRoad. This initiative integrates data analytics, behavioral science, and policymaking to improve road safety, demonstrating a strong partnership between government, international organizations, and private expertise.

The project also actively involves academic institutions such as the National University of Architecture and Construction of Armenia (NUACA) and the Armenian National Agrarian University, which contribute research and analysis on road traffic accidents, black spot identification, and safety measures. These universities collaborate with government bodies and law enforcement on data-driven road safety studies and proposals.

The UN Road Safety Fund (UNRSF) supports projects that foster coordination among government ministries (Territorial Administration, Internal Affairs, Health), NGOs, and academic partners to improve road safety data management and policy implementation.

The UN Digital Connectivity Strategy for Armenia explicitly promotes collaboration between government, industry, and academia to position Armenia as a regional innovation leader, which includes transport and road safety technology as key sectors.

4.2.1.4. SMEs and Other Innovation Initiatives

There are several Small and Medium Enterprises (SMEs) and companies in Armenia with an emerging role in deploying road safety technologies.

For instance, Avenue Consulting Group provides geospatial consulting and training services, including GIS and remote sensing technologies, which are critical for road safety data analysis and infrastructure planning.
A joint venture of IRD Engineering and FRED Engineering is actively involved in Armenia, providing engineering services and sustainable, innovative road safety solutions. They have contracts with the Armenian Road Department Fund to supervise road safety improvement works on accident-prone road sections, including conducting road safety audits, inspections, and training.

The EU-SMEDA project (Support to SME Development in Armenia) has contributed to fostering innovation and capacity building among SMEs, including those involved in technology and infrastructure sectors. This project supports linking research institutions and private sector businesses to promote innovation, which can include road safety technologies.

The Armenian government and international partners emphasize digital transformation and SME digitalization as part of national strategies, which supports the growth of SMEs capable of deploying advanced technologies, including those relevant to transport and road safety.

4.2.2. VEHICLE SAFETY & AUTOMATION

4.2.2.1. ADAS and AV Policies

Advanced Driver Assistance Systems (ADAS) main vehicle safety systems are not yet compulsory for new vehicles in Armenia as per the EU Vehicle Safety Regulation (EU) 2019/2144.

Armenia is a member of the Eurasian Economic Union (EAEU), which has its own vehicle regulations and standards that differ from the EU's. There is no publicly available evidence that Armenia has adopted or aligned its vehicle safety regulations to make ADAS features (such as automatic emergency braking, lane-keeping assist, etc.) mandatory for new vehicles, as required under EU Regulation 2019/2144.

Current Armenian regulations focus more on import quotas and tariff exemptions for electric vehicles rather than mandating specific advanced safety technologies on all new vehicles entering the market.

While global and regional markets, including the EU, China, and India, are moving toward compulsory ADAS features in new vehicles, Armenia's vehicle import and safety regulatory framework has not yet incorporated these requirements. The Armenian market primarily imports vehicles from countries like the UAE, the US, and China, where ADAS adoption is growing but not uniformly mandated for all new vehicles.

Armenia is actively pursuing a transition towards smart and sustainable mobility, with government initiatives promoting electric vehicles, digital technologies, and intelligent transport systems as part of a broader green and smart mobility agenda. However, there is no publicly available evidence of a formal, comprehensive national strategy or dedicated action plan specifically focused on the deployment of automated vehicles.

Armenia's current transport policies emphasize electric vehicle adoption, public transport modernization, and sustainable urban mobility, with digital technologies (including automation and real-time data systems) recognized as critical enablers for future transport efficiency and safety[123].

While these efforts support a transition toward advanced transport technologies, no specific legislation or regulation targeting automated vehicles deployment is currently in place or publicly announced. The focus remains on building the necessary infrastructure, regulatory environment, and market conditions that could eventually accommodate AV deployment.

[123] https://en.aravot.am/2025/05/19/359850/

There is no publicly available evidence of pilot projects specifically testing automated vehicles (AVs) in Armenia. However, there have been pilot projects testing automated vehicles in the country. In 2017, an Armenian-produced electric self-driving car, assembled by National Instruments, was unveiled and tested at the DigiTec Tech Expo in Yerevan. The vehicle included driver-assist devices such as radars, cameras, and laser equipment, and underwent simulation-based testing by a team of Armenian engineers and designers.

As of 2025, the CSIE Foundation is actively conducting research and development in advanced navigation and control systems for autonomous vehicles, with the aim of building an Autonomy Centre of Excellence in Armenia[124].

4.2.2.2. Networks and Connectivity

According to Statista and recent digital connectivity reports, Armenia is projected to achieve 100% 4G coverage nationwide in 2025. As of mid-2024, about 80% of settlements in Armenia are covered by 4G networks, with ongoing expansion expected to reach near full coverage within the next couple of years. 5G coverage is currently available primarily in Yerevan, Gyumri, Vanadzor, and some other urban centers, with network operators like UCOM and Viva actively expanding 5G base stations and capacity. GSMA Intelligence data indicates that 96.7% of mobile connections in Armenia use broadband networks (3G, 4G, or 5G), reflecting widespread access to modern mobile technologies[125].

4.2.2.3. Infrastructure Readiness & Digitalization

Armenia has formal guidelines and regulations in place for road inspection and maintenance. The country has initiated steps toward regular road safety inspections that include assessments of road conditions, markings, and signs, which are important for overall road safety and would be necessary for automated vehicle (AV) navigation in the future. However, these inspections are not yet fully comprehensive or explicitly tailored for AV requirements.

The Armenian government has announced plans for mandatory road safety audits starting from the design and construction phases of roads and continuing one year after commissioning. This includes inspections of road infrastructure elements such as markings, signs, and pavement conditions to improve safety on accident-prone sections.

A recent initiative states that all roads in Armenia will undergo safety inspections soon, aiming to identify and mitigate risks associated with road infrastructure and maintenance.

The Armenia Transport Sector Development Strategy 2020 and the Government's 2021-2026 Action Plan include targets to improve the condition of roads and reduce accidents caused by road malfunctions by up to 20% by 2026. These plans imply ongoing monitoring and maintenance efforts, including road surface and signage conditions.

Road safety projects supported by international organisations emphasize rehabilitation and safety improvements on key corridors, including pavement upgrades and installation of safety barriers, which involve regular inspections and quality control.

[124] https://csiefoundation.am/en
[125] https://www.statista.com/outlook/co/digital-connectivity-indicators/armenia

However, there is no specific public information indicating that inspections are yet fully aligned with the detailed and frequent standards required for AV navigation, such as continuous real-time monitoring or highly precise digital mapping of road infrastructure.

The **Law of the Republic of Armenia on Ensuring Road Traffic Safety** and related government decisions establish procedures and responsibilities for the maintenance, repair, and inspection of roads and their engineering structures. These regulations assign public administration bodies, local self-government, and authorized entities to carry out road construction, reconstruction, repair, and maintenance within their competences.

A government decision (No. 350-N, 2011)[126] sets out detailed procedures for the mandatory technical inspection of vehicles, including requirements for technical inspections and maintenance of vehicles to ensure road safety. While this focuses on vehicle inspection, it reflects a structured regulatory approach to safety and maintenance.

The Armenian government has announced plans for systematic safety inspections of all roads in the near future, including compliance checks on road signs, markings, and other technical requirements during road construction and maintenance. Licensing and supervision mechanisms are in place for organizations conducting technical inspections and maintenance activities, ensuring adherence to established standards and procedures .

Armenia's current and planned road infrastructure projects incorporate some digital elements and advanced technologies, but full-scale deployment of Vehicle-to-Infrastructure (V2I) systems and machine-readable signage is still limited and mostly in the early stages.

Armenia's road projects focus heavily on climate resilience, safety improvements, and road asset management, with some pilot schemes for "safe villages" that improve vulnerable road user safety through engineering measures, but these do not yet include advanced digital infrastructure for connected vehicles.

4.2.3. ELECTRIC VEHICLES & SUSTAINABILITY

4.2.3.1. Policy and Incentives in Place

Armenia does not have a dedicated, comprehensive national strategy or action plan specifically for the deployment of electric vehicles (EVs). While there are important initiatives and incentives—such as zero import duties for EVs, pilot projects, and some policy development, there is no formal, continuous framework or national e-mobility roadmap in place yet.

However, Armenia does have broader, government-approved programmes and strategies for green energy, energy efficiency, and renewable energy development (e.g., the Program on Energy Saving and Renewable Energy for 2022–2030, and the Republic of Armenia Energy Sector Development Strategic Programme to

[126] ORDER OF THE GOVERNMENT OF THE REPUBLIC OF ARMENIA of February 15, 2007 No. 344. About approval of procedure for carrying out obligatory technical inspection of vehicles public in the Republic of Armenia. https://cis-legislation.com/document.fwx?rgn=77459

2040). These strategies set ambitious targets for renewables and low carbon energy and include some measures that indirectly support EV adoption as part of the country's overall climate and energy goals[127].
Armenia has specific policies and incentives in place—and under further development—to accelerate and promote electric vehicles (EVs), as follows:

- **Import Tax and VAT Exemptions**: Through 2025, electric vehicles can be imported into Armenia without customs duties or value-added tax (VAT). This policy is designed to make EVs more affordable and attractive to consumers. The VAT exemption on EV imports is legislated to last until at least 2030, and there are ongoing discussions to extend other incentives.
- **Tariff Quotas**: Armenia has a preferential import quota system for EVs, with a quota of 8,000 vehicles for 2024–2025 at zero customs duty, as agreed within the Eurasian Economic Union (EAEU).
- **Charging Infrastructure Development**: The government and Armenian Energy Agency have supported programs such as Plug.am, which has installed free public charging stations across the country. Regulatory barriers to expanding charging infrastructure have also been removed, allowing a diverse range of entities to enter the market.
- **Parking and Environmental Tax Exemptions**: Owners of fully electric vehicles are exempt from parking fees in Yerevan and from environmental taxes on greenhouse gas emissions.

These incentives are explicitly aimed at reducing greenhouse gas emissions, improving air quality, and cutting noise and pollution from road traffic, especially in urban centers like Yerevan, where air pollution is a significant health issue. Armenia is leveraging support from international organizations for EV infrastructure and public transport electrification, including pilot projects and technical assistance.

There are ongoing efforts to develop a comprehensive package of policy and regulatory measures for scaling up electric mobility. Demonstration projects for electric buses and fleet vehicles are also underway, with guidelines and monitoring frameworks being established.

4.2.3.2. EV Charging Infrastructure

There are several ongoing projects in urban areas (mainly Yerevan): 420 new stations planned for 2024, with existing stations already operational. On the interurban road network, there are at least 95+ stations, including those operated by PLUG.am and Team Telecom Armenia, with coverage on major routes and in regional cities

The majority of EV charging still occurs at home, but public infrastructure is expanding (see Figure 4.1), with a clear urban focus and growing interurban/highway coverage[128].

The average charging speed at public EV stations in Armenia is currently between 22 kW (AC, medium-speed) and 120 kW (DC, fast/ultra-fast), with the network rapidly shifting toward higher-speed DC charging as new infrastructure is deployed. Most new stations, especially on highways and in major cities, offer fast or ultra-fast charging, enabling 80% charge in 25–30 minutes for compatible vehicles.

[127] https://www.thegef.org/sites/default/files/documents/10280_CEO_Endorsement_request.pdf
https://eu4climate.eu/wp-content/uploads/2023/05/ARMENIA_EU4Climate_2023.pdf
https://evnreport.com/raw-unfiltered/renewable-energy-armenias-opportunities-and-limits/
[128] https://ev-armenia.net/en/map

Figure 4.1: Number and Spatial Distribution of EV Charging Stations in Armenia

4.2.3.3. EV Trends

Table 4.1 below shows that the number of newly registered EVs has sharply increased over the period 2018-2023 in Armenia. Until 2021, new electric vehicles (EVs) were registered domestically, but in 2022 and 2023, there was a notable increase in imported EVs.

Table 4.1: Newly Registered / Imported EVs in Armenia, 2018-2023

Year	2018	2019	2020	2021	2022	2023
EVs Registered / Imported	12 registered	145 registered	358 registered	1,898 registered	≥1,041 registered. 3,833 imported	6,513 imported

4.2.3.4. Affordability

For used vehicles, the price difference between EVs and ICEVs is often minimal or even negligible, depending on model, age, and condition. New EVs tend to be priced higher than new ICEVs, but this premium is generally less than $5,000 for many models, and sometimes even less due to government incentives and zero import duties on EVs in 2025.

The zero-import customs duty quota for EVs (up to 8,000 vehicles in 2025) has made EVs more affordable, narrowing the price gap significantly compared to ICEVs. The wide availability of used EVs imported by individuals and dealers has contributed to a competitive pricing environment, often bringing EV prices close to those of similar used ICEVs. New EVs price range is from 12.000 to 45.000 USD. Most of the EVs imported are new and from China.

4.2.3.5. Barriers

The government has implemented a quota of 8,000 vehicles, followed by a 15% customs tax. Currently, discussions are underway to increase the quota, aiming to further incentivize safe driving, given that electric vehicles are equipped with most safety standards.

- **Limited Charging Infrastructure**: Few public charging stations, especially outside major cities and highways.
- **Regulatory obstacles** restrict electricity resale and complicate charger installation.
- **Lack of Technical Expertise**: Shortage of trained EV technicians and service centers; Limited knowledge in charging network development and grid integration.
- **Absence of Coherent Policy**: No comprehensive national e-mobility strategy or clear regulatory framework. Inconsistent incentives and unclear long-term support.
- **Consumer Concerns**: Range anxiety and doubts about charging availability and reliability; Low public awareness about EV benefits and maintenance.
- **Battery Management Issues**: No regulations for battery reuse, recycling, or disposal, posing environmental risks.

4.2.4. BIG DATA, DIGITALIZATION & AI APPLICATIONS

4.2.4.1. Data Standards

Armenia has a well-developed and evolving framework for data standards and governance in the public sector, combining legal, technical, and institutional measures to promote secure, interoperable, and transparent data management aligned with international best practices[129]. The key points of this framework are as follows:

- **National Digitalization Strategy and Regulatory Framework**: Armenia's Ministry of High-Tech Industry leads the country's digital transformation efforts under the Government Digitalization Strategy 2021–2025. The strategy emphasizes digital connectivity, data protection, digital trust, etc.
- **Data Protection and Personal Data Governance**: The Personal Data Protection Agency under the Ministry of Justice oversees the lawful processing and protection of personal data in Armenia, ensuring compliance with data protection laws and maintaining registries of data processors.
- **Interoperability and Data Exchange Standards**: The Information Systems Agency of Armenia (ISAA) is implementing a next-generation interoperability platform based on Estonia's open-source X-Road technology. This platform enables secure, trusted, and coordinated data exchange between government bodies, following the "once only" principle to avoid redundant data requests and improve service delivery.
- **Cloud-First Policy and E-Government Initiatives**: Armenia has adopted a "Cloud-First" policy mandating cloud solutions for public information systems to enhance security, scalability, and infrastructure reliability. The country ranks highly in the United Nations E-Government Development Index, reflecting strong e-government services, telecommunication infrastructure, and human capital.

[129] https://armenia.un.org/sites/default/files/2025-02/UN_Armenia_DigitalConnectivity_2025_F.pdf

- **Open Government Partnership and Transparency**: Participation in the Open Government Partnership has driven improvements in public service provision, resource management, and public trust through enhanced transparency and data governance.
- **Strategic Data Infrastructure Development**: Armenia is developing Tier 3 data centers to support high-availability, reliable data management for both government and business sectors, underpinning the country's digital economy and data governance capabilities.
- **Legal Framework for Access to Information**: Draft laws on access to information and public data management are under discussion, aiming to regulate data transparency and governance further, though some civil society organizations have raised concerns about proposed regulations.

4.2.4.2. Data Security

Law on Protection of Personal Data (2015, amended 2018 and ongoing updates): This is the principal legislation regulating the collection, processing, storage, and protection of personal data in Armenia. It defines personal data broadly, including biometric and sensitive categories, and requires data controllers and processors to obtain explicit consent from data subjects, except in certain legally specified cases. The law mandates transparency, purpose limitation, data minimization, and security measures such as encryption and access control.

Cybersecurity Legislation and Policy: Currently, Armenia does not have a dedicated, fully enacted cybersecurity law, but a draft Law on Cybersecurity is under consideration, aiming to regulate cyber incident detection, notification, prevention, and resolution, especially for critical information infrastructure and vital services. The National Security Service oversees cybersecurity policy and protection of government networks in the absence of a formal strategy.

International Commitments: Armenia is a party to the Council of Europe's Convention on Cybercrime (Budapest Convention), which criminalizes unauthorized access and manipulation of personal data in computer systems. It also adheres to the European Convention on Human Rights, which includes data protection provisions.

Institutional Oversight: The Personal Data Protection Agency (PDPA), established under the Ministry of Justice, is the independent authority responsible for enforcing data protection laws. It can investigate compliance, impose administrative fines (up to 500,000 AMD per violation), order corrective measures (blocking, rectification, destruction of data), and suspend or ban unlawful data processing activities.

Data Subject Rights and Protections: Individuals have rights similar to GDPR, including:

- Right to access their personal data and information about its processing
- Right to rectify inaccurate data
- Right to erasure ("right to be forgotten") when data is no longer necessary or unlawfully processed
- Right to restrict processing under certain conditions
- Right to withdraw consent and be informed of consequences
- Protection of biometric and sensitive data with additional safeguards.

- Consent must be explicit, informed, and can be given in writing, electronically (with digital signature), or verbally if clearly evidenced.

Security and Technical Measures: Data controllers and processors are required to implement adequate technical and organizational security measures, including encryption, access controls, and regular security audits, to protect personal data from unauthorized access, loss, alteration, or dissemination. Specific government decisions prescribe security standards for processing biometric data and data stored outside information systems.

Application to Drivers' Personal Data: Driver data collected through monitoring technologies (e.g., speed cameras, GPS tracking) falls under the scope of the Data Protection Law. Such data must be processed lawfully, with consent or other legal grounds, and protected from unauthorized access.

Entities processing driver data must notify the PDPA if biometric or special category data is involved and ensure data subjects are informed of their rights and processing purposes.

Enforcement mechanisms are in place to sanction violations involving misuse or inadequate protection of drivers' personal data.

Comparison with EU GDPR: Armenia's data protection law is aligned in many respects with GDPR principles, including consent, data subject rights, purpose limitation, and security requirements. Differences include lower maximum fines, a narrower territorial scope focused on data processing within Armenia, and some procedural distinctions in consent and enforcement.

4.2.4.3. High Resolution Digital Maps

Currently Armenia has no high-definition (HD) maps specifically designed for autonomous vehicle (AV) deployment as defined by the industry standard.

Armenia currently possesses high-resolution topographic and satellite maps suitable for general navigation, urban planning, and GIS applications, but these do not meet the stringent requirements of HD maps for AVs (centimeter-level accuracy, semantic layers, real-time updates).

There are no information or reports that Armenia has developed HD maps with LiDAR-based 3D point clouds, semantic annotations, or real-time update capabilities necessary for autonomous driving.

4.2.4.4. Real-Time Traffic Management

The UNDP's real-time road accident platform processes incident reports from police and cameras within seconds to minutes, enabling immediate visualization of black spots and trend analysis. For example, a 2023 pilot on the Yerevan-Proshyan highway reduced speeding violations by 18% through rapid data-driven interventions.

Armenia's traffic management ecosystem effectively combines centralized TMCs, multi-source data integration, and real-time driver communication to enhance urban and interurban mobility. While Yerevan leads in adaptive technologies, expanding sensor networks to rural areas and improving data interoperability remain priorities. These advancements align with national goals to halve road fatalities by 2030.

Traffic Management Centers

Armenia has traffic management centers for both main urban and interurban roads.

The Technology Management Center of Yerevan City oversees urban traffic, including adaptive signal systems. At national level, the Tactical Management Center of the Traffic Police and the Road Department monitor major highways and interurban corridors.

Multiple Data Sources are collected and processed:

- Traffic flow (cameras, sensors, counters)
- Speed and violations (speed cameras, ANPR)
- Weather (national meteorological stations)
- Incident reports (police, citizen apps)
- Public transport data (urban bus/tram systems)

Real-Time Driver Information data is used to provide real-time information to drivers:

- Digital message boards on main roads
- Mobile apps (e.g., “Check the Road Conditions in Armenia”)
- Online platforms with live updates on closures, detours, and weather

Congestion / Access Management data supports congestion and access management:

- Adaptive traffic signals in Yerevan adjust based on real-time flows
- Planned access controls (e.g., electronic road pricing, bypasses)
- Data-driven planning for infrastructure upgrades and traffic policy

Incident / Accident Detection system is used for incident and accident detection:

- Automated alerts from cameras and sensors
- Crowd-sourced reports via mobile apps
- Police and emergency dispatch coordinated through management centers

Monitoring driver behavior

Armenia has a robust system of speed and traffic cameras, supported by a penalty point and fine-based enforcement regime for key violations such as speeding and mobile phone use while driving. Fleet operators and some private users can access advanced telematics and GPS-based monitoring, with feedback provided via apps and dashboards. While in-vehicle driver monitoring cameras are not widely documented in public use, private security and telematics solutions may include such features. Behavioral feedback to drivers is emerging, mainly through targeted digital campaigns, but is not yet a universal, real-time feedback system for all drivers.

Yerevan and other Armenian cities are adopting a range of ITS applications, with particular progress in smart traffic signals, public transport telematics, and real-time driver information, while VMS and further digital infrastructure are likely to expand in the coming years.

There are numerous Sensors and Monitoring Technologies Used:

- **Speed Cameras and Traffic Cameras**: Armenia has an extensive network of automatic speed cameras and traffic cameras, particularly in the capital Yerevan and on major highways. As of recent years, there are over 170 speed cameras nationwide, with many intersections and streets in Yerevan under surveillance. These cameras detect speeding, red-light violations, and, in some cases, other infractions such as driving without seat belts or using a mobile phone while driving.
- **Vehicle GPS Data and Telematics**: Private companies in Armenia, such as GPSGAMMA, offer GPS-based vehicle tracking and driver behavior monitoring services for both company and personal vehicles. These systems can analyze driving patterns, including speeding, harsh braking, rapid acceleration, and route adherence, using GPS/GLONASS devices installed in vehicles.
- **In-Vehicle Cameras and Surveillance**: Private security services and some fleet management companies offer video surveillance (CCTV) for vehicles, which may include driver-facing cameras. However, the primary government systems focus on external traffic and speed cameras.
- **Behavioral Interventions via Smartphones**: Recent initiatives, such as the UN Road Safety Fund project, have used targeted digital messages sent to drivers’ mobile phones to encourage safer driving, particularly targeting speeding behavior. However, there is no continuous smartphone-based telematics monitoring for the general driver population.

Applications for pedestrians and cyclists

Armenia’s ITS applications for pedestrian and cyclist safety currently focus on data-driven identification of danger zones, physical upgrades to crossings, and infrastructure planning. While advanced systems like automated cyclist detection and intelligent pedestrian signals are not yet widespread, ongoing innovation and international partnerships are laying the groundwork for more sophisticated safety solutions.

Armenia’s ITS applications for pedestrian and cyclist safety currently focus on data-driven identification of danger zones, physical upgrades to crossings, and infrastructure planning. While advanced systems like automated cyclist detection and intelligent pedestrian signals are not yet widespread, ongoing innovation and international partnerships are laying the groundwork for more sophisticated safety solutions.

4.3. GEORGIA

4.3.1. GENERAL TECHNOLOGY READINESS

In Georgia, there has been an implementation of the National Broadband Development Strategy (2020–2025): This strategy underscores Georgia's ambition to become a digital corridor between Europe and Asia, focusing on expanding broadband access and fostering a conducive environment for digital innovation. Considerable progress has been made in key areas. Georgia has demonstrated strengths in its startup capacity, reflecting a supportive environment and ecosystem for entrepreneurial ventures. The country benefits from a favorable legal environment for businesses and an effective ICT regulatory framework, which are conducive to technological advancement.

4.3.1.1. Strategies, Programmes and Investments

Georgia recognizes digitalization as a strategic priority—investing in connectivity, reforming public services, establishing coordinating bodies, and working toward advanced tech policies like AI and blockchain. The country has several formal national-level strategies and initiatives centered around digital transformation and technology adoption:

- **National Broadband Development Strategy 2020–2025**: Established on 9 January 2020, this strategy aims to expand broadband infrastructure across Georgia, enhance internet speeds and accessibility, close the urban-rural digital divide, and position Georgia as a regional "digital corridor" connecting Europe and Asia. Implementation is underway via the Log-in Georgia project, supported by the World Bank, which includes rolling out fiber-optic broadband to thousands of settlements and fostering 5G trials.
- **e-Government / Digital Transformation Strategy 2021–2025:** Developed under the UN University and UNDP, this national public-sector digital transformation strategy specifically covers 2021–2025. It outlines a 36-month roadmap for overhauling public service delivery and e-government, aligning with global best practices through stakeholder consultations
- **Digital Transformation Council (est. 2022)**: Established by the Ministry of Economy and Innovation & Technology Agency in March 2022, this high-level council brings together government, private sector, academia, and international partners (e.g., US, UK, Israel, Estonia). Its mandate includes shaping policy for a national digital-economy strategy & implementation plan, with support from the World Bank.
- **Emerging Digital Governance & Enabling Frameworks:** Georgia has built substantial e-governance infrastructure—such as Digital Signature Infrastructure, e-public financial management (ePFM), and data exchange platforms—guided by the Digital Governance Agency and aligned with public administration reforms since 2015.

The UN E-Government Survey (2024) highlights that Georgia is in the process of drafting AI, blockchain, cybersecurity, and smart-city policies, though a dedicated national AI strategy is still pending.

Georgia has also established a robust legal framework supporting technology adoption, particularly focusing on data privacy, inclusive governance, and regulatory compliance. The main pillars are:

Data Protection Law: On 14 June 2023, the Georgian Parliament adopted a revamped Law on Personal Data Protection, largely aligning with EU GDPR standards. Most provisions came into effect on 1 March 2024, with key obligations (like appointing Data Protection Officers and conducting Data Protection Impact Assessments) becoming mandatory 1 June 2024. Covered entities include public bodies and private sectors such as banks, airlines, telecoms, and any organization processing large volumes of data.

Key Obligations Under the Law:

- Appointment of Data Protection Officer (DPO)

- Data Protection Impact Assessments (DPIA)
- Incident Reporting
- Consent & Processing clarified consent rules, particularly for special categories of personal data.

Moreover, the Personal Data Protection Service (PDPS), established in March 2022, serves as the independent data protection authority. PDPS issued normative acts detailing breach criteria, DPIA thresholds, video/audio monitoring rules, DPO requirements, and international data transfer procedures.
Georgia is actively investing in transport and road safety technologies through a mix of national strategies and international support. The **2023–2030 National Transport and Logistics Strategy** and its **2023–2024 Action Plan** prioritize safety standards, digital systems, and EU regulatory alignment (MoESD, 2023). Internationally, organisations have committed over **€350 million**, including a **€16 million Global Gateway grant (2023)** for safety upgrades on the East–West Highway (EIB, 2023). The **Twinning Project (2022–2024)** has also supported Georgia in developing a national road safety database and action plan, targeting a 25% reduction in fatalities (EU Twinning, 2023). Meanwhile, pilot initiatives like **smart traffic lights in Batumi (2022)** illustrate progress in urban traffic tech (UNDP Georgia, 2022).

4.3.1.2. Knowledge and Operational Capacity in Government and Transport / Road Operators

There is a moderately strong command of data and technology-based road safety within key agencies, evidenced by:

- Specialized graduate training—via police and internal affairs academies—and international workshops on technical standards.
- Opening of dedicated training pathways like iRAP accreditation for road engineers and crash-data analysts.
- Operational deployments: database systems, trauma registries, speed enforcement tech, and infrastructure star-rating.

However, broader institutional scaling is still in progress. Many road and enforcement agencies are still building internal expertise—in part due to limited human resources and reliance on external support (e.g., EU twinning).

University-level qualifications (e.g. master’s in data science or technology management) among senior managers are still not systematically widespread—though targeted training and police academy programs are growing steadily.

Georgia’s approach to road safety technology is characterized by moderate multi-sector collaboration—combining government policy leadership, academic research capacity, and industry innovation through some formalized projects and partnerships.

4.3.2. VEHICLE SAFETY & AUTOMATION

4.3.2.1. ADAS and AV Policies

Georgia does not have a dedicated national strategy or action plan specifically addressing the deployment of automated vehicles. While the **2023–2030 National Transport and Logistics Strategy** outlines objectives for digitalization and the development of Intelligent Transport Systems (ITS), it does not explicitly mention autonomous vehicles or provide a roadmap for their integration into the national transport system. As of now, Georgia does not have publicly documented pilot projects specifically focused on testing autonomous vehicles (AVs). While there have been advancements in related areas, such as intelligent transport systems and connected vehicle technologies, dedicated AV testing initiatives have not been reported.

4.3.2.2. Networks and Connectivity

While 4G coverage is extensive (89.34% of the country's total land area), 5G services are still in the early stages of deployment, primarily concentrated in urban centers (77% of the country’s land area, but only **1.37%** of the population).

4.3.2.3. Infrastructure Readiness & Digitalization

The Georgian Roads Department (GRD), operating under the Ministry of Regional Development and Infrastructure, is responsible for maintaining and inspecting the country's road infrastructure. These regulations are outlined in the **Law of Georgia No 1913 of 23 December 2017**, which governs road safety and maintenance standards in the country.

To assess road conditions, the GRD employs various methods, including:

- **Visual Inspections**: Regular on-site evaluations by engineers and maintenance personnel to identify issues with road markings, signage, and pavement conditions.
- **Automated Systems**: Utilization of technology to monitor and assess road conditions efficiently.
- **Public Reporting**: Encouraging citizens to report road hazards, missing signs, or damaged markings through official channels.

Georgia has started integrating digital infrastructure elements into its road network, particularly focusing on Intelligent Transport Systems (ITS) and Vehicle-to-Infrastructure (V2I) technologies.

Vehicle-to-Infrastructure (V2I) Systems: The Georgian Roads Department (GRD) has initiated the deployment of V2I systems to enhance road safety and traffic management. This includes the installation of roadside units (RSUs) at key intersections to enable communication between vehicles and traffic infrastructure. These systems facilitate real-time data exchange, allowing for applications such as emergency vehicle prioritization, dynamic traffic signal control, and hazard warnings.
Machine-Readable Signage: While the widespread implementation of machine-readable signage is still in the early stages, there are efforts to standardize road markings and signage to improve sensor detection for autonomous vehicles.
Digital Infrastructure in Road Design Projects: In current and future road design projects, there is a growing emphasis on incorporating digital infrastructure elements. This includes the integration of sensors, communication networks, and data analytics platforms to monitor and manage road conditions in real time.

4.3.3. ELECTRIC VEHICLES & SUSTAINABILITY

4.3.3.1. Policy and Incentives in Place

In 2018, the Georgian government launched the **"Green Policy – Eco-friendly Transport" project**, aiming to replace 90% of the national vehicle fleet with electric cars within the next decade. This ambitious plan includes:

- Importing over 2,000 electric vehicles through a car-sharing system in the first year.
- Encouraging the establishment of EV manufacturing plants, with negotiations underway with major automakers.
- Introducing leasing schemes to make EVs more accessible to consumers.

Related policies and incentives include:

- **Tax Breaks for EV Imports**: Georgia offers significant tax incentives for importing hybrid and electric vehicles. EVs are exempt from import taxes, while hybrids benefit from reduced taxes compared to traditional combustion engine vehicles. This policy makes EVs more affordable and encourages their adoption.
- **Development of EV Manufacturing**: The government is actively negotiating with international automakers to establish EV manufacturing plants in Georgia. Cities like Kutaisi are being considered for these facilities, leveraging the country's strategic location and existing automotive infrastructure.

4.3.3.2. EV Charging Infrastructure

Approximately 67 public EV charging stations are operational across Georgia. Cities like Tbilisi, Batumi, and Kutaisi have a higher concentration of charging stations, primarily Level 2 chargers, supporting daily commuting needs. Major highways connecting cities are equipped with DC Fast Chargers to ensure EV drivers can travel between urban centers without range anxiety. Rural areas still face challenges, with fewer charging stations, leading to "charging deserts" where access to EV charging is limited.

4.3.3.3. EV Trends

Table 4.2 below shows that the number of newly registered EVs have increased 5 times between 2018-2023, rising from 2.4% of newly registered passenger cars in 2018, to 9.3% on 2023.

Table 4.2: Number of newly registered EVs in Georgia 2018-2023

	2018	2019	2020	2021	2022	2023
Total number of registered vehicles	1,289,014	1,339,281	1,404,428	1,490,178	1,563,165	1,680,436
Number of passenger cars (new registration)	53,880	54,156	54,535	55,599	54,282	54,147
Number of EVs (new registration)	1285	1902	2164	2393	3283	5052

4.3.4. BIG DATA, DIGITALIZATION & AI APPLICATIONS

4.3.4.1. Data Standards

Georgia has initiated several efforts to establish data standards and guidelines for data governance in the public sector, though challenges remain in achieving comprehensive implementation.

Freedom of Information (FOI) Legislation: Access to public information is governed by Chapter 3 of the General Administrative Code of Georgia, in effect since 1999. However, this framework is considered outdated and in need of modernization to align with current international standards and practices. The government has committed to developing a new law on freedom of information as part of its annual action plan for implementing the EU-Georgia Association Agreement.

Government Decree No. 219 (2013): This decree mandates that public agencies proactively publish certain categories of information on their websites. While it has played a role in enhancing access to public information, the decree's scope and effectiveness are limited, and there is a recognized need for updates to address current challenges and expand the list of information to be published.

Transparency International Georgia's "Ten Open Data Guidelines" (2011): These guidelines provide a framework for public agencies to create open data websites, emphasizing principles such as completeness, timeliness, accessibility, machine-readability, and non-proprietary formats. They serve as a practical tool for agencies aiming to improve data transparency and usability.

Advocacy for Open Data Standards: Organizations like the Institute for Development of Freedom of Information (IDFI) have been advocating for the adoption of open data standards and the improvement of legislation related to access to public information. Their efforts include promoting the use of open data among stakeholders and sharing best practices with public servants.

Open Data Portal (data.gov.ge): Managed by the Digital Governance Agency (formerly the Data Exchange Agency), this portal aims to provide access to government-held data. However, the portal's effectiveness is hindered by the lack of a legal obligation for public institutions to publish data, leading to inconsistent and infrequent updates. Some municipalities, such as Akhaltsikhe and Kutaisi, have developed and adopted Open Data Strategies to improve data collection, processing, and publishing practices. These local efforts are part of a broader commitment to enhance open data governance at the municipal level.

EU-GDPR is adopted in the country. There are several challenges and gaps remaining, however. Despite reforms and commitments, Georgia lacks an enforceable and comprehensive legal framework to regulate the disclosure of government-held data, leading to challenges in data availability and accessibility.

Moreover, public institutions vary in their data management capabilities, with some lacking the necessary tools and standards for effective data governance. This inconsistency hampers the development of a cohesive and interoperable data ecosystem.

4.3.4.2. High Resolution Digital Maps

A high-resolution digital map is available at: www.maps.tbilisi.gov.ge

4.3.4.3. Real-Time Traffic Management

While Georgia is modernizing its road infrastructure and installing traffic cameras and speed enforcement technology, it currently lacks fully developed, integrated real-time traffic management centers and systems like those found in more developed ITS environments. The existing systems are more focused on enforcement and safety monitoring than on dynamic traffic management or real-time travel information.

Road operators have no access to Real-Time Traffic Information. There are Traffic Detectors and LPR cameras where data is collected from and is used internally. There is an ongoing project to facilitate data and distribute to road users in the future.

Traffic Management Centers

Tbilisi has a traffic management center that monitors traffic with CCTV and manages traffic lights. Plans are in place to expand its capacity and staff for broader services. A nationwide speed enforcement system and dedicated cameras fine drivers for violations.

Georgia has been investing in expanding its road safety and traffic surveillance infrastructure. The Ministry of Internal Affairs and the Roads Department use traffic cameras, including some with license plate recognition technology, primarily for law enforcement and road safety monitoring. Data types include traffic flow monitoring via cameras, speed enforcement technologies, and weather information gathered from meteorological services. However, these systems tend to be fragmented rather than fully integrated into a unified traffic management platform.

Real-time traffic information for drivers is limited. Some urban areas have basic traffic cameras, but widespread, dynamic variable message signs (VMS) or mobile apps providing live traffic updates are not yet commonly deployed at scale.

Monitoring Driver Behaviour

Mobile Speed Detectors (Contactless Patrolling): The Ministry of Internal Affairs (MIA) of Georgia has introduced mobile speed detectors, also known as "contactless patrolling," to monitor speeding drivers. These devices are installed in unmarked police vehicles and can detect and record speed violations without the need to stop the vehicle. The recorded data is then used to issue fines to the vehicle owner. This system aims to deter speeding by making drivers aware that they may be monitored at any time and location.

Smart Cameras with Analytical Software: Since 2017, Georgia has equipped several cities with smart cameras capable of detecting various traffic violations, including speeding, red light running, and unauthorized lane usage. These cameras are supported by analytical software with capabilities such as automatic license plate recognition. The footage captured is connected to a unified video surveillance system, enabling 24/7 real-time monitoring and enforcement.

Moreover, project documentation is already prepared for implementation for highway traffic management center, and it will be supported by international financial institutions. This will include the follwoign ITS applications:

- Variable message signs,

- Variable speed limits,
- Dynamic Speed Display signs,
- Speed cameras

Applications for Pedestrians and Cyclists

Intelligent pedestrian crossings with activation buttons will be piloted over the next three years.

4.4. MOLDOVA

4.4.1. GENERAL TECHNOLOGY READINESS

4.4.1.1. Strategies, Programmes and Investments

The **Digital Transformation Strategy of the Republic of Moldova for 2023-2030**, Government Decision 650/202, adopted on 6 September 2023 by the Cabinet of Ministers, is the current flagship framework guiding Moldova's digital future. Key pillars include[130]:

- Digital society – universal access to e-services, digital literacy, broadband infrastructure.
- ICT sector growth – strengthening research, innovation, startup ecosystem.
- Digital economy – cloud, AI, big data adoption by enterprises, e-commerce growth.
- Smart public sector – e-government, e-ID, paperless administration, cross-border services.
- Cybersecurity & inclusivity – national CERT, cyber policies, data protection, digital rights.
- International integration – mutual e-signature recognition, EU digital market integration

The Ministry of Economic Development and Digitalization (MEDD) and Electronic Government Agency coordinate governance, supported by a National Digital Transformation Council. Progress is tracked via EU-aligned indicators like DESI, cybersecurity indices, and benchmarks (e.g., by 2024: 75% of public services digital; by 2030: 100%).

In late 2024 and early 2025, the government issued a **White Paper on AI and Data Governance**, aligning national AI strategy with EU frameworks. Relevant laws are the Law on the Protection of Personal Data, n.133/2011; Law no.60/2012 on the social inclusion of people with disabilities and the Order of the Minister of Transport and Road Infrastructure on the approval of technical conditions for vehicles accessible to persons with disabilities no. 101/2017.

Moldova is actively supported by international programs to implement large-scale road reconstruction, upgrade key corridors to European safety norms, and prepare for smart transport systems through ITS frameworks and EU-aligned technical specifications.

[130] mded.gov.md

4.4.1.2. Knowledge and Operational Capacity – Intersectoral Collaboration

The knowledge and operational capacity of stakeholders in the country is limited to some dedicated training sessions, and through hands-on experience with managing using such technologies. There are approximately 892 students with the information technology profile graduating each year in the country, and approximately 689 students with the engineering profile. Intersectoral collaboration is taking place through consultations and dialogue on the subject of road safety.

4.4.2. VEHICLE SAFETY & AUTOMATION

4.4.2.1. ADAS and AV Policies

In June 2021, Chisinau City Hall introduced a Strategy for Intelligent Transport and Mobility, that includes an action plan[131] . It focuses on:

- Traffic flow optimization and management systems
- Public transport improvements
- Electric mobility integration
- A central ITS platform to support data-driven decisions and real-time interventions

However, this effort is a localized, urban-level deployment, not a national automated vehicle plan.

4.4.2.2. Networks and Connectivity

Nearly the entire country (98 %) benefits from outdoor 4G access across its land area. While nationwide 5G coverage is still in development, the main operators, Orange and Moldcell, have concentrated on their 5G networks in major urban areas. The most extensive coverage is found in Chișinău, the capital.

4.4.2.3. Infrastructure Readiness & Digitalization

Moldova maintains a **comprehensive and formal set of guidelines** for road inspection and maintenance via the National Road Administration. These norms cover everything from periodic inspections to material usage and safety barriers.

In 2023, the following drafts were released for public consultations[132]:

- Ghid privind întreținerea structurilor rutiere (Guide on maintaining road structures)
- Instrucțiuni privind evidența tehnică a drumurilor (Instructions for technical record-keeping of roads)

To date, there are no large-scale V2I (vehicle-to-infrastructure) deployments or machine-readable signage implemented on Moldova's national road network. Traffic detection systems, GPS-enabled public transport, and centralized traffic management software are being rolled out in Chisinau.

[131] moldova.un.org

[132] https://particip.gov.md/ro/document/stages/proiect-cp-ghid-privind-intretinerea-structurilor-rutiere-proiect-cp-instructiuni-privind-evidenta-tehnica-a-drumurilor/10857?utm_source=chatgpt.com

4.4.2.4. Barriers

The main barriers in the deployment of smart vehicle technologies and ADAS are the homologation requirements which are not fully transposed, and the lack of adequate technological infrastructure.

4.4.3. ELECTRIC VEHICLES & SUSTAINABILITY

4.4.3.1. Policy and Incentives in Place

I. The Ministry of Energy’s 2024 **“Fast and Green 1000” EV rally**, backed by EU, UNDP, and GIZ, highlighted existing charging infrastructure and identified gaps—especially adapters and payment systems.

II. **Integrated National Energy & Climate Plan (INECP) 2025–2030:** Approved in February 2025 by the Cabinet, it's a binding roadmap targeting 30% renewables by 2030, energy efficiency, decarbonization, grid modernization, and promotion of non-polluting transport[133].

III. Moldova joined the Global Cleantech Innovation Programme (GCIP) in 2022, supporting SMEs and startups in clean tech across transport, energy efficiency, renewable production.[134]

IV. Moldova has introduced several policies and incentives aimed at accelerating the adoption of electric vehicles (EVs), focusing on environmental sustainability, economic benefits, and energy efficiency:

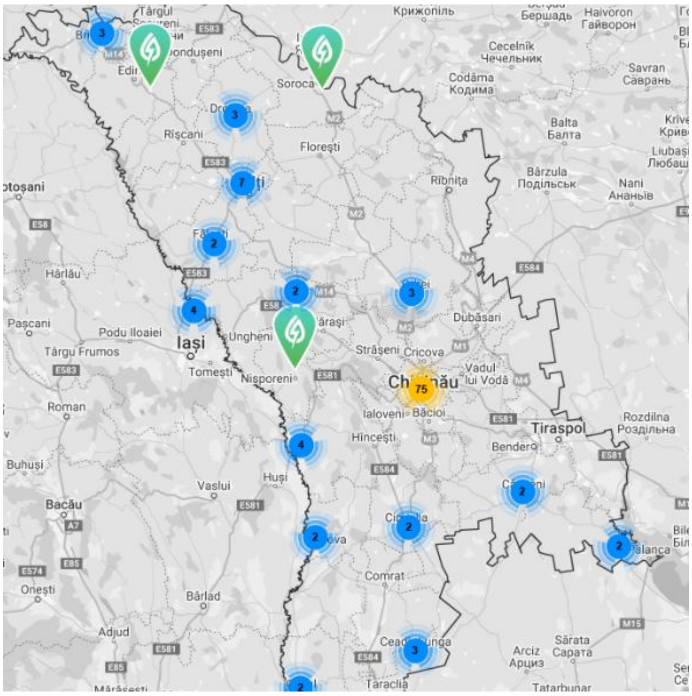
- **VAT Exemption**: Electric vehicles are exempt from VAT upon importation, reducing the initial cost for consumers.
- **Customs Duty Exemption**: EVs imported into Moldova are exempt from customs duties, further lowering the financial barrier to entry.
- **Exemption from Road Tax**: Owners of electric vehicles are exempt from road tax, providing ongoing cost savings.
- **Subsidies for Charging Stations**: The government offers subsidies for the installation of EV charging stations, encouraging the development of necessary infrastructure to support EV adoption.
- **Public Charging Points**: Initiatives are underway to increase the number of public charging points, enhancing the convenience of owning and operating an EV.

4.4.3.2. EV Charging Network

In the Republic of Moldova, there are more than 150 recharging points for electric vehicles. They are located on the main urban routes in the country and near border crossings, to facilitate safe travel for electric vehicles (see Figure 4.2).[135]

[133] https://www.energie.gov.md/en/content/integrated-national-energy-and-climate-plan-approved-government?
[134] https://gcip.tech/country/moldova/
[135] https://evpoint.md/ro/retea_de_statii

Figure 4.2: Number and spatial distribution of EV charging stations in Moldova



Source: EVpoint.md

4.4.3.3. EV Trends

Table 4.3 below shows the number of EVs newly registered in Moldova. While from only 42 EVs in 2018, there were up to 729 on 2922, the country does not show a dynamic development in the field similar to its neighboring countries.

Table 4.3: Number of Newly Registered EVs in Moldova, 2018-2023

	2018	2019	2020	2021	2022	2023
Number of EVs (new registration)	42	191	210	396	729	611

4.4.4. BIG DATA, DIGITALIZATION & AI APPLICATIONS

4.4.4.1. Data Standards

Moldova's commitment to data governance is anchored in several key legislative acts:

- **Law No. 305/2013 on Public Sector Information (PSI)**: This law, aligned with EU directives, facilitates the reuse of public sector information and mandates the publication of open data[136].
- **Law No. 195/2024 on the Protection of Personal Data**: Fully transposing the EU's General Data Protection Regulation (GDPR), this law outlines provisions for data subject rights, duties of data operators, and data transfer requirements. It is set to come into effect two years after publication.

[136] age.gov.md

- **Law on Access to Public Information (2000)**: This law guarantees the public's right to access information held by public authorities, with certain exceptions related to state secrets and personal data.
- The **e-Governance Agency (eGov),** established in 2010, is the central body responsible for Moldova's digital transformation. Its mission includes modernizing public services, ensuring data exchange between public institutions, and enhancing information security.
- The **National Centre for Personal Data Protection (NCPDP)** oversees the enforcement of data protection laws and has issued guidelines to ensure the proper application of access to information provisions, balancing transparency with personal data protection.

The national open data portal, date.gov.md, serves as a central repository for public data sets, enabling citizens, businesses, and developers to access and utilize government data.

4.4.4.2. High Resolution Digital Maps

Moldova's official NSDI portal—**inds.gov.md**—provides access to geospatial layers such as cadastral maps, address points, roads, land parcels, and administrative boundaries. It supports high-resolution vector data and metadata over various themes.

4.4.4.3. Real-Time Traffic Management

Moldova has recently begun implementing real-time traffic management systems, mostly in Chișinău.

Traffic Management Centers

Chișinău's Traffic Monitoring Centre (TMC) was launched in November 2024, supported by the EU's "MOVE IT like Lublin" initiative. It integrates ~180 traffic cameras, road sensors, public transit data, parking monitors, and radars to offer live traffic data for optimizing signal timings, reducing delays, and enhancing safety.

The system provides real-time information for both public transport users (e.g., trolleybus arrival times seen at stops) and general drivers. The National Road Administration deployed a centralized platform integrating road traffic counters and weather data[137].

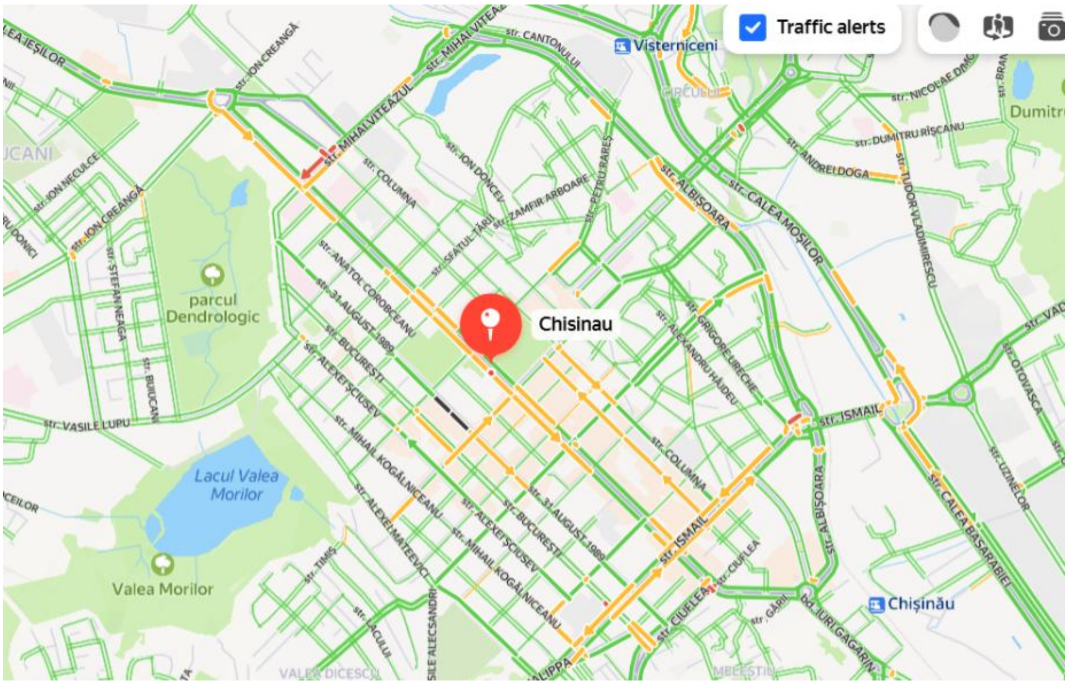
On national roads, the National Road Administration has installed web cameras that ensure real-time monitoring and visualization of road conditions. The road traffic monitoring systems are managed by the Traffic Monitoring and Control Center.

Driver Monitoring and Information

There are a couple of navigation apps covering Moldova and offering a real-time traffic overlay leveraging GPS data from user devices. This provides live visibility of congestion levels on highways and major roads (see Figure 4.3).

[137] https://undp.cz/world-cities-day-making-urban-life-more-comfortable-through-modern-technology-october-31/

Figure 4.3: Chisinau Real-Time Traffic Information



Source: Yandex map

Moreover, the **App Tranzy** - https://tranzy.app/ - is a mobile app that guides travelers through the city, when they choose to take the bus or tram. It provides travelers with real-time updated information about lines, the location of nearby stations, the arrival time of the means of transport at the station, the optimal routes depending on the chosen departure point, the distance to the destination, and traffic alerts.

Applications for pedestrians and cyclists

According to available reports, signalized pedestrian crossings equipped with pedestrian-activated traffic lights are present in Moldova; however, details regarding their distribution and technical specifications remain unclear.

4.5. CROSS-COUNTRY SUMMARY

Table 4.4 which follows provides a cross-country summary consolidating the findings for each of the four survey themes.

Table 4.4: Cross-country summary across the four survey themes

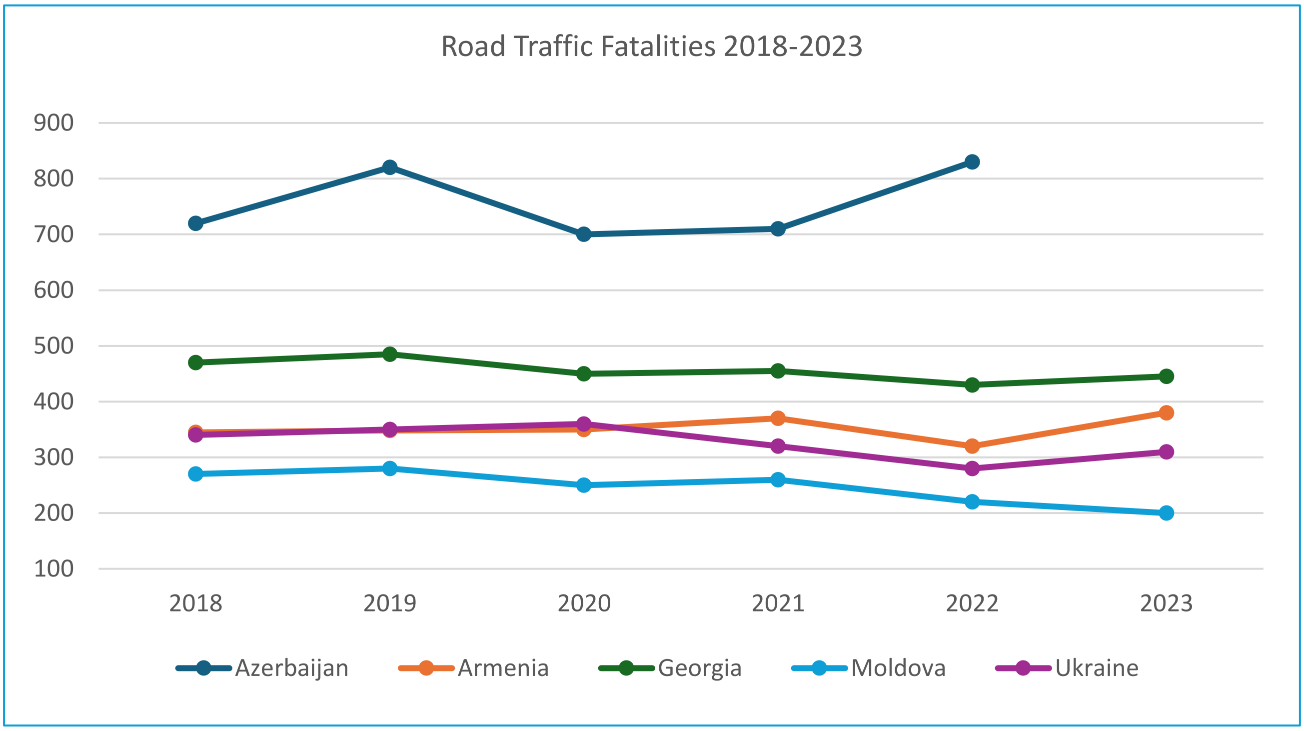
Survey Themes	Armenia	Georgia	Moldova	Benchmarking Notes (Cross-Country Comparison)
(i) General Technology Readiness	Strong digital government; Ministry of High-Tech Industry leads; cloud-first, interoperability via X-Road; PDPA ensures GDPR-aligned data protection; Tier-3 data centers; high 4G coverage (~80% settlements, 100% projected 2025), limited 5G (urban focus).	Data governance developing; FOI law outdated; Open Data guidelines exist; some municipal strategies; strong urban broadband coverage, 5G concentrated; institutional overlaps; eGov adoption uneven.	EU-aligned data governance; Law on Public Sector Info & GDPR-aligned personal data law; eGov central body; open data portal (date.gov.md); NSDI GIS data; improving broadband, early 5G rollout; rural digital gaps remain.	Armenia shows strongest institutional digital maturity; Georgia strong in municipal initiatives; Moldova rapidly aligning with EU standards.
(ii) Vehicle Safety & Automation (ADAS/AV)	ADAS not compulsory; limited AV pilot projects (2017 self-driving electric car demo); policies focus on EVs & road safety; road inspections ongoing; network readiness improving; traffic cameras extensive (170+); driver data monitored; no HD AV maps yet.	No dedicated AV plan; ITS development ongoing; some V2I deployment; traffic cameras for speed & enforcement; real-time traffic info limited; pedestrian/cyclist ITS limited.	No national AV policy yet; road safety regulations EU-aligned; TMC and traffic sensors being installed; ADAS limited; HD maps not implemented; ITS for urban roads emerging.	All countries early-stage in automation; Armenia leads traffic monitoring & enforcement; Georgia shows V2I pilot progress; Moldova aligning AV legal framework.
(iii) Electric Vehicles & Sustainability	Incentives: zero import duty & VAT, 8,000-vehicle quota; 6,513 EVs imported in 2023; charging network growing (2024: urban 420 stations, 95+ interurban); affordability improving. Barriers: limited rural chargers, technical expertise, no national e-mobility strategy, battery recycling gaps.	Green Policy Eco-Transport: 90% fleet EV target; import tax exemptions; EV manufacturing promotion; 67+ public chargers (urban), highways with fast DC chargers; rural gaps (“charging deserts”); EV registrations 1,285→5,052 (2018–2023).	Incentives: VAT & customs exemptions, road tax exemption; >150 chargers (urban & border areas); EV registrations modest (42→729→611); pilot EV projects; charging infrastructure and affordability barriers remain.	Armenia: fastest EV adoption growth, expanding fast-charging; Georgia: ambitious strategic plan & manufacturing focus; Moldova: moderate growth, EU-aligned incentives.
(iv) Big Data, Digitalization & AI Applications	Data standards mature: X-Road interoperability, open gov’t, cloud-first, PDPA oversight; traffic management: Yerevan & national TMCs; 170+ speed cameras, GPS telematics, driver apps; real-time traffic info for highways & urban areas; ITS for pedestrians/cyclists emerging; HD maps not available for AVs.	Data governance developing; FOI outdated; open data initiatives; high-res digital maps (Tbilisi GIS); traffic enforcement & cameras strong; TMC in Tbilisi supervises cameras & traffic lights; limited real-time info; ITS projects for highways and pedestrian crossings planned.	EU-aligned data & privacy laws; eGov platform; NSDI geospatial data; Chisinau TMC (2024) integrates 180+ cameras, sensors, transit & weather data; real-time traffic apps (Yandex Maps, Tranzy) available; pedestrian crossings signalized but limited coverage.	Armenia: most integrated data & traffic monitoring; Moldova: fast-growing real-time traffic & ITS ecosystem; Georgia: strong enforcement & analytical capability but fragmented.

CHAPTER 5. SYNTHESIS OF ROAD SAFETY TECHNOLOGY READINESS IN THE EAP REGION

5.1. ROAD SAFETY DEVELOPMENTS

As mentioned in section 1.2 of this report, Eastern Partnership (EaP) countries have still large margins of road safety improvements. Fatality rates in several EaP countries significantly exceed the European Union-27 average of 4.5 deaths per 100,000 population recorded in 2021. Moreover, progress has been slow, and recent road fatality figures show a stagnation, and even an increase in traffic fatalities. As can be seen in Figure 5.1, Armenia, Georgia and Azerbaijan have shown increased traffic fatalities on 2022-2023 compared to previous years, and only Moldova shows a continuous decreasing trend.

Figure 5.1: Number of Traffic Fatalities per year in the EaP Countries, 2018-2023.

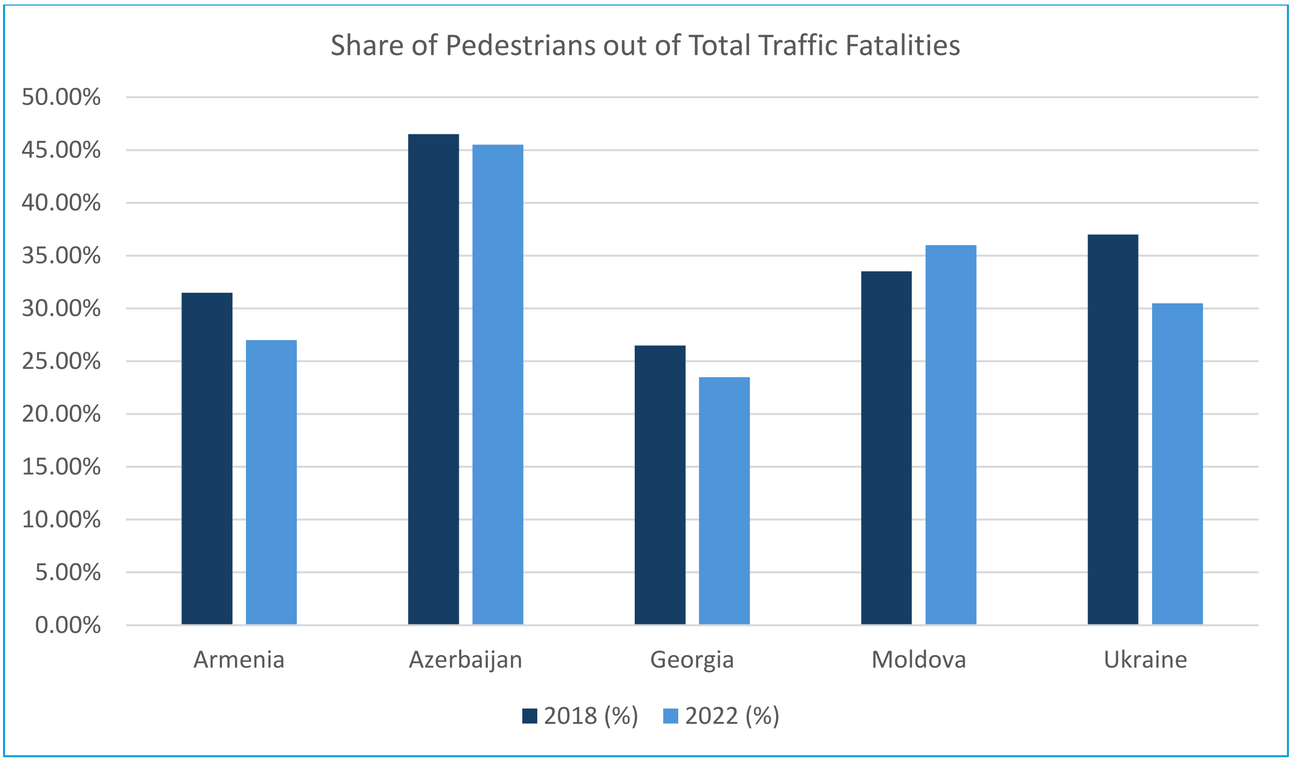


Source: WHO, 2023*Ukraine fatalities are divided by 10 for visibility

At the same time, VRUs still have a disproportional burden of casualties compared to motorists; for instance, the share of pedestrians among the total traffic fatalities in the EaP countries ranges between 27% (Georgia) to 45% (Azerbaijan), with an increasing trend between 2018-2023 in several EaP countries, i.e. Armenia, Georgia & Ukraine (see Figure 5.2).

A similar stagnation, or even increasing trend, has been noted in several EU countries, and it has been noted that the conventional approaches with engineering, enforcement and education measures may not be sufficient to reach the global target of halving fatalities between 2020-2030. In the same context, it is argued that transport and road safety technologies could complement traditional interventions, but their short-term impact is limited by low adoption, infrastructure constraints, and fleet composition. In the medium to long term, advanced vehicle technologies, ADAS, and sensor systems may support real-time traffic risk detection, provided enabling infrastructure and governance measures are in place.

Figure 5.2: Share of Pedestrian Fatalities out of Total Traffic Fatalities in the EaP Region, 2018 and 2022.



[Source: WHO, 2023]

5.2. TECHNOLOGY READINESS

The review of the state of the art and the questionnaire survey carried out within this study revealed that **the level of knowledge of ITS and the awareness of their importance in road safety improvements are very high in the EaP region**. However, **their actual readiness to deploy these technologies and systems, and benefit from them in the short-to-medium-term, are moderate to limited**. A comparative analysis is presented in the following sections.

5.2.1. GENERAL GROWTH AND TECHNOLOGY READINESS

As a first step, the overall economic growth of the countries has been examined. Despite the COVID-19 pandemic and the political turmoil in the EaP region, all countries have exhibited an overall increase in their GDP per capita between 2018 and 2023 (see Figure 5.3). However, there seems to be no specific evidence of the relationship between economic growth and technology investment or technology penetration in the region.

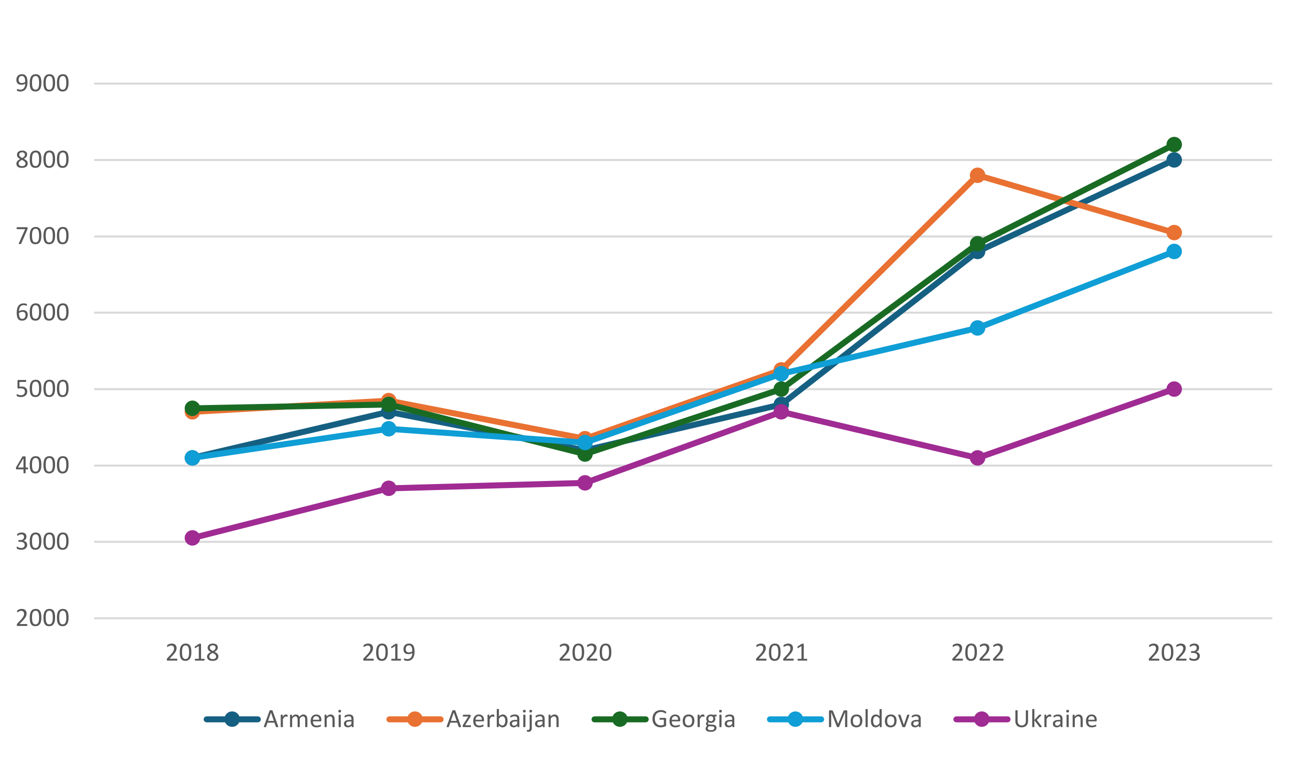
Tables 5.1-5.3 show a comparative evaluation of EaP countries using three popular technology readiness scales. Table 5.1 displays the NRI (**Network Readiness Index**, 2023), which measures how prepared a country is to use ICT for development and competitiveness. The NRI is organized into four main pillars, each containing several sub-pillars and indicators.

- Technology: Evaluates the adoption and use of ICT.
- Assesses the readiness and skills of individuals, businesses, and governments to utilize ICT.

- Governance: Examines the political and regulatory environment affecting ICT development.
- Impact: Measures the economic and social impacts resulting from ICT usage.

All EaP countries demonstrate moderate performance across the NRI pillars: Georgia and Moldova excel in governance and impact, yet fall behind in technology adoption and people's skills, whereas Armenia stands out with the highest score in technology adoption.

Figure 5.3: GDP pe capita in the EaP Region, 2018-2023, USD



Data Source: WHO, 2023

Table 5.1: NRI Index Breakdown and Ranking of EaP Countries, 2023

Country	Tech Score (Rank)	People	Governance	Impact
Armenia	46.37 (51)	38.85	52.86	60.09
Georgia	44.15 (62)	44.10	59.11	49.82
Moldova	37.31 (84)	37.53	61.79	55.83
Azerbaijan	40.16 (75)	39.31	50.45	54.38

Data source: Portulans Institute

Another relevant technology readiness index is the GII (**Global Innovation Index**, 2024)[138]. Table 5.2 shows the EaP countries' ranking. Overall, Moldova has a long-term good performance, revealing consistency and systematic efforts. However, Georgia and Armenia show a dynamic development with high improvement in

[138] https://www.wipo.int/web-publications/global-innovation-index-2024/en/gii-2024-at-a-glance.html#:~:text=Results%20of%20the%20Global%20Innovation,the%20socioeconomic%20impact%20of%20innovation.

their ranking, also compared to previous years. Georgia ranks 57th, followed by Ukraine (60th) and Armenia (63rd). However, Azerbaijan has not been able to demonstrate innovation potential comparable to its neighbors.

Table 5.2: Global Innovation Index Ranking of EaP Countries, 2024

Country	GII Rank (out of 133)	Trend vs 2023	Notes
Georgia	**57th**	↑ Entered top 60	Rank improved; strong in institutions, human capital, business sophistication
Armenia	**63rd**	↑ Up 9 places	Consolidating improvement
Ukraine	**60th**	↓ Down 5 places	4th among lower-middle-income; struggles in institutions and human capital
Moldova	**68th**	– Consistent	Recognized as long-term over-performer
Azerbaijan	**95th**	– Modest showing	Behind regional peers

Data Source: World Intellectual Property Organization

Finally, the **Digital Accessibility Rights Evaluation (DARE) Index 2020**[139] assesses the country's progress in implementing digital accessibility for people with disabilities. Table 5.3 shows that for the EaP region (out of up to 137 countries), Moldova leads with a solid score of 60, ranking 28th globally, 13th in Europe, and top 5 among similar-economy peers. Azerbaijan is moderate at 49, placing 44th globally and 3rd within Central Asia. Georgia shows room for improvement with a score 25.5, ranking 101st globally. Armenia scores lowest at 13.5, without listed ranks—indicating minimal progress in DARE Index measures.

Table 5.3: Digital Accessibility Rights Evaluation (DARE) Index 2020 for the EaP Countries

Country	DARE Score (/100)	Global Rank	Regional Rank	Peer-Group Rank	Implementation Rank
Armenia	13.5	N/A	N/A	N/A	N/A (weak performance)
Azerbaijan	49	44	3rd in Central Asia	11 (of peer econ. group)	34
Georgia	25.5	101	25	29	41
Moldova	60	28	13	5	15

The EaP countries rank reasonably well among middle and low-to-middle income nations in technology readiness, showing progress but still encountering significant challenges in innovation, capacity, and human capital development. The EaP countries show **moderate technology readiness compared to middle-income**

[139] https://g3ict.org/news-releases/g3ict-releases-the-second-edition-of-the-dare-index-real-world-data-for-advocates-and-policy-makers-to-track-digital-accessibility-implementation

peers, with some progress in governance and institutional frameworks that could facilitate future technology deployment, though significant challenges remain in adoption, human capital, and infrastructure. Moreover, the NRI Impact pillar (see Table 5.1) shows that, **although the implementation of technology is relatively low, the impact of implemented technology and ICT adoption is high**, indicating a very promising trend once readiness and investment increase.

5.2.2. TRANSPORT AND ROAD SAFETY TECHNOLOGY READINESS

In this section, a more focused approach is taken by presenting a comparative assessment of EaP countries with respect to transport and road safety technologies.

First, the **quality of vehicle fleet and vehicle standards / regulations** in the countries are compared. Although automated vehicles are not deployed or foreseen to operate in large-scale deployments in the near future in the EaP region, the state of the vehicle fleet, in terms of ADAS deployment and key safety systems is paramount to road safety.

Table 5.4 provides an overview of existing regulations vehicles standards in the EaP region, with focus on their adherence to UN standards and regulations as per the indicators of the global status report on road safety 2023 (WHO, 2023). For that correspondence, the abbreviations are as follows:

- UN_PTI: On PTI country adheres to corresponding UN or equivalent international safety regulation.
- UN_FrontSide: On front and side impact protection country adheres to corresponding UN or equivalent international safety regulation.
- UN_SafetyBelts: On safety belts and safety belt anchorages country adheres to corresponding UN or equivalent international safety regulation.
- UN_ESC: On ESC country adheres to corresponding UN or equivalent international safety regulation.
- UN_Pedestrians: On pedestrian protection country adheres to corresponding UN or equivalent international safety regulation.
- UN_ABS: On ABS country adheres to corresponding UN or equivalent international safety regulation.

The region mostly relies on imported used vehicles, which are rarely well regulated. Only Azerbaijan and Moldova limit the age of imports (10 and 7 years), and only Azerbaijan enforces emissions standards. Georgia and Ukraine offer tax incentives for importing newer, eco-friendly used vehicles. Only Armenia and Georgia fully follow all UN Core vehicle regulations on ADAS and safety systems. Azerbaijan complies only with ESC, ABS, and pedestrian protection standards.

Table 5.4: Overview of Vehicle Standards (New and Imported) in the EaP Countries

	Used vehicles regulations and standards						UN core vehicle regulations					
Country	**Year**	**Type**	**Age limit**	**Technical standards**	**Environmental standards**	**Remarks**	**UN_PTI**	**UN_FronsSide**	**UN_SafetyBelts**	**UN_ESC**	**UN_Pedestrian**	**UN_ABS**
Armenia	2017	Permitted	None		UNECE			✓	✓	✓	✓	✓
Azerbaijan	2023	Permitted	<10 years	ABS, Airbag	EURO 4					✓	✓	✓
Georgia	2017	Permitted	None			2 types of taxation based on engine volume and age		✓	✓	✓	✓	✓
Moldova	--	Permitted	<7 years	LHD								
Ukraine	2017	Permitted			Euro 6 for LDVs	Lower taxes for vehicles with lower engine volumes and CO2 emissions						

The majority of **EaP countries have initiated efforts to deploy and invest in EVs**, and relevant data are available:

- Armenia: Benefiting from a large-scale import of ~5,780 EVs between mid-2023 and early 2024.
- Azerbaijan: Remains in early stages with no public EV count data.
- Georgia: Leading among its regional peers, with ~9,000 EVs registered, reflecting robust growth[140].
- Moldova: ~6,600 pure EVs and nearly 58,000 hybrids, representing ~64,000 electrified vehicles—significant progress from just a few hundred in 2019[141].

Simultaneously, all counties are establishing a charging system for major urban and interurban roads, while also offering financial incentives to both importers and consumers.

However, when it comes to actual ITS and AI applications, there are several challenges faced by the countries. Table 5.5 and Table 5.6 present a comparative summary of the current transport technology applications in the three EaP countries who responded to the survey (their responses were complemented with further review of the state of the art for the purpose of this comparison).

[140] Sources: Agenda.ge and the LEPL Service Agency of the Ministry of Internal Affairs
[141] https://ipn.md/en/more-than-6-600-electric-cars-registered-in-moldova-7967_1108574.html

Table 5.5: Transport and Road Safety Technology Adoption – Interurban Roads (2025)

Interurban roads	Armenia	Georgia	Moldova
Speed Cameras	**Widely deployed** on highways/interurban roads	Widespread & enforced	**Widely deployed**
Dynamic Speed Display Signs		Limited urban use (schools/construction), not nation-wide	Limited urban use (schools/construction), not nation-wide
Variable Message Signs (VMS)	Not currently deployed, though infrastructure and digital upgrades underway	Occasional (highways/construction), no holistic deployment	A few VMS deployed in Chișinău for traffic alerts and roadworks
Variable Speed Limits	Not currently deployed, there is a potential for future implementation	Not currently deployed	Not currently deployed
Road Condition Monitoring	**In use** with electronic data for maintenance and planning	No real-time sensors	Integration of weather sensors and pavement condition monitoring is limited but planned
Real-Time Traffic Data	**Expanding**, supports smart mobility and route optimization	Via Google/Yandex; no public feeds or traffic center	**Available** in Chisinau and on main highways and interurban roads

Table 5.6: Transport and Road Safety Technology Adoption – Urban Roads (2025)

Urban roads	Armenia	Georgia	Moldova
Driver Information	In use (Electronic schedules at some stops, live tracking via mobile apps, multilingual signage in metro)	In use (Digital signage at bus stops and traffic corridors: used for arrival times, route info, and real-time alerts)	Limited static info. In use only via mobile app (private sector)
Optimisation of Traffic Signals	Piloted and expanding, through smart crossroads with real-time traffic flow sensors and adaptive signals	In use SCOOT system installed in Tbilisi; dynamic signal control based on traffic flow.	In use Central traffic centre Chisinau managing ~180 signals
Public Transport Telematics	In use. Live vehicle tracking, unified payment system, route optimization	In use. GPS-tracked buses, live arrival times, smart fare systems (cards/apps)	In use. Basic tracking; data shown in apps
Other (Smart Mobility, Real-Time Data)	Expanding. Real-time data collection, digital planning, safe village schemes near urban areas	Partly, via central traffic center and private map services; integration with public platforms is in progress.	In use in Chisinau. National traffic & weather platform + Chișinău monitoring centre
Intelligent Pedestrian Crossings	Piloted and expanding (evidence-based redesign, raised crossings, speed humps) - Focus on high-risk “black spots” and traffic calming	Partly. Pedestrian actuated signals sporadically in use.	Partly. Pedestrian actuated signals sporadically in use. Acoustic signals for disabled users.
Pedestrian Flow Analysis Systems	Partly (real-time crash data analytics, geospatial mapping). Supports targeted safety interventions and planning	Not yet deployed	
Cyclist Detection Systems	Not yet deployed	Cycling infrastructure exists but lacks ITS features	Cycling infrastructure exists but lacks ITS features

The following are **examples of good practices in the region**:

- All countries use **traffic count sensors and speed cameras**, at least in the main urban areas and on the major interurban road network. However, their application is limited to traffic enforcement purposes.
- Armenia and Georgia have solid **systems of traveler information when it comes to public transport**, with real-time vehicle tracking, driver information and alert.
- Georgia and Moldova apply **real-time traffic management on their capital cities** to a certain extent. The traffic signal optimization SCOOT system is installed in Tbilisi, providing dynamic signal control based on traffic flow. A new traffic management center was established in Chisinau, with state-of-the-art technology for real-time traffic monitoring.
- All countries have **pilot projects in sight** to integrate traffic information with other relevant information such as weather, disruptions etc. within their smart city development plans. While the aforementioned initiatives show operational progress, integration remains **partial and not yet fully scaled** across the region.
- Armenia is using **pavement sensors for road condition monitoring and maintenance purposes.**

Nevertheless, it should be noted that most countries continue to prioritize the enhancement of their physical transport infrastructure, such as the ongoing development and improvement of road networks.

5.3. BARRIERS TO TECHNOLOGY DEPLOYMENT

5.3.1. LESSONS LEARNT FROM THE STATE OF ART

Connected and Automated Vehicles (CAVs), Electric Vehicles (EVs), and Artificial Intelligence (AI)-driven technologies promise significant improvements in road safety, environmental sustainability, and operational efficiency. CAVs reduce reliance on human drivers by leveraging sensors, AI, and V2X communication to navigate safely and efficiently. EVs contribute to lower greenhouse gas emissions and offer cleaner alternatives to combustion engines, while big data and AI technologies enable predictive traffic management, real-time safety alerts, and dynamic route optimization. Usage-Based Insurance (UBI) models enhance driver accountability by personalizing premiums based on behavior, encouraging safer and more fuel-efficient driving[91]. EU initiatives like NAPCORE and C-Roads exemplify institutional commitment to integrating these technologies through harmonized standards, real-time data sharing, and infrastructure development. Altogether, these innovations present an opportunity to redefine mobility systems to be safer, cleaner, and more user centric.

However, realizing these benefits requires overcoming substantial technical, ethical, and structural challenges. AI systems in road safety face prediction accuracy issues due to inconsistent data quality, model complexity, and the unpredictability of real-world conditions. Infrastructure costs for smart transport networks remain prohibitive, especially in underserved regions. In the case of CAVs, unresolved issues around cybersecurity, legal liability, and public trust hinder widespread adoption, while their benefits remain geographically and socially uneven. Similarly, EV adoption is disproportionately higher in wealthier areas, with limited access and infrastructure in marginalized communities, raising concerns about transport equity. The production of EVs also entails significant environmental and social costs, particularly in developing nations where raw material extraction occurs.

Moreover, privacy and data protection regulations, especially under the EU's GDPR, present barriers to the broader deployment of AI, C-ITS, and telematics, which require extensive personal data collection. These multifaceted challenges demand coordinated policy, technological innovation, and inclusive planning to ensure these technologies serve all populations equitably and safely.

Technological readiness plays a critical role in determining the pace and success of integrating CAVs, EVs, Driver telematics and AI-based systems into mainstream transport networks. Without robust, interoperable infrastructure and mature digital ecosystems, even the most advanced technologies may fall short of their potential. For CAVs, this includes ensuring reliable V2X communication, widespread 5G or future 6G connectivity, and resilient cybersecurity frameworks capable of protecting real-time systems from external threats. Similarly, the transition to EVs hinges on the availability and strategic placement of charging stations, power grid upgrades, and sustainable battery supply chains. AI and telematics systems require not only accurate, high-frequency data but also scalable edge computing capabilities to process this information efficiently while respecting data privacy constraints. Bridging the gap between research, development, and real-world deployment necessitates not just technological maturity but also proactive governance, investment in digital infrastructure, and public-private collaboration. The KPIs measuring technological readiness and the stakeholder questionnaire in the following sections constitute informed, purpose-made steps towards stakeholder engagement, necessary to harmonize technological readiness perception and advise all necessary next steps for smooth technological integration.

5.3.2. INSTITUTIONAL AND REGULATORY BARRIERS

There are several institutional and regulatory barriers to the deployment of transport technologies in the EaP region:

- **Lack of Specific AV Regulations and Frameworks**: The region does not have dedicated policies, laws, or regulatory frameworks specifically addressing the deployment, testing, and operation of automated vehicles. While international bodies such as UNECE are developing AV regulations expected by 2026, Armenia has yet to adopt or prepare aligned legislation to govern AVs domestically.
- **Alignment with International Standards**: Not all EaP countries have harmonized their vehicle safety and AV regulations with advanced frameworks like the EU Vehicle Safety Regulation (EU) 2019/2144 or UNECE WP.29 AV rules, creating a regulatory gap for AV deployment.
- **Institutional Capacity and Expertise**: The institutional knowledge and operational capacity in government agencies and transport operators regarding advanced technologies remain in early stages. While data-driven road safety initiatives exist, the expertise and experience necessary to regulate, monitor, and manage transport technologies are still developing.
- **Infrastructure and Digital Readiness**; Most countries' road infrastructure, with the exceptions of certain urban areas, currently lacks widespread deployment of digital elements critical for Vehicle-to-Infrastructure (V2I) systems and machine-readable signage. This limits the operational environment needed for reliable deployment of AI applications, including autonomous vehicle navigation.
- **Market and Import Constraints**: The vehicle market in the region is dominated by imports, with a strong recent surge in electric vehicle imports. However, these imports are primarily conventional or electric vehicles, not equipped with the basic ADAS of the UN standards.

- **Data Privacy, Cybersecurity, and Liability Issues**: While emerging regulations emphasize data systems safety, cybersecurity, and data governance / management, there is little experience with implementing such formal guidelines to address specific technology-related concerns, such as road user privacy, unauthorized access etc., posing barriers to social acceptance and legal clarity.
- **Technology Acceptance**: There is no information on the trust on autonomous systems and general transport technologies acceptance in the region. The launched stakeholders survey of this study received no responses in this respect.

5.3.3. TECHNOLOGICAL / TECHNICAL BARRIERS

The main technological and technical barriers to the deployment of transport / road safety technologies and AI systems in the EaP region include several interrelated challenges:

- **Limited Digital Infrastructure and Road Environment Readiness**: The region's road network currently lacks widespread deployment of digital infrastructure elements such as Vehicle-to-Infrastructure (V2I) systems, machine-readable signage, and high-precision digital mapping.
- **State of the road infrastructure, traffic conditions and inclusiveness**: Transport and safety technologies need to be able to accommodate motorized vehicles, pedestrians, cyclists and diverse road conditions. The EaP road environment includes mixed modes of transport and variable infrastructure quality, which may complicate sensor performance and data transmission. Weather conditions and road maintenance also affect the accuracy of ITS, AI and autonomous systems.
- **Data and Connectivity Limitations**: While 4G coverage is extensive, 5G networks—which enable low-latency, high-bandwidth communication necessary for V2I, real-time traffic management, and driver monitoring/information, are still very limited, mainly to urban centers.
- **Financial and Investment Constraints**: Significant investments are required to upgrade infrastructure, develop digital systems, and support technology testing and deployment. Several countries in the region face financial challenges and rely heavily on external funding and public-private partnerships to advance smart mobility initiatives, which may slow technology and digital infrastructure development.
- **Integration with Existing Transport Systems**: Effective technology deployment requires integration with existing transport networks and systems, including traffic management, public transport, and road safety monitoring. Foundational ITS and digital platforms are emerging but not yet fully mature, limiting the integration and efficiency of AI, telematics, and autonomous systems.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1. A BENCHMARKING FRAMEWORK

In section 5.2, the technology readiness of EaP countries was presented based on various international scales and national statistics. Moreover, a detailed analysis of the status of the selected EaP countries was presented with respect to transport and road safety technologies. In this section, an attempt to benchmark the EaP countries is made, based on an adaptation of the EU Technology Readiness Levels (see section 3.2.4). More specifically, the following **CRS (Country Readiness Scale)** will be used:

- **CRS 1 – Awareness:** Technology is on the policy radar. Discussions, position papers, or exploratory studies exist, but no concrete actions or regulations are in place. Pilots and testing are still non-existent.
- **CRS 2 – Framework:** Initial policies, strategies, or regulations are introduced. Small-scale pilots or early deployments begin, but adoption is fragmented, and infrastructure is underdeveloped.
- **CRS 3 – Structured Pilots:** Coordinated pilots and demonstration projects are underway, backed by regulatory support. Uptake grows among early adopters. Initial integration with existing systems and compliance with basic legal frameworks (e.g., data protection) is evident.
- **CRS 4 – Scaling:** Infrastructure deployment and market adoption expand significantly. Technology is tested at scale under real-world conditions, and regulatory mechanisms become more robust. Broader stakeholder engagement ensures interoperability and standardization.
- **CRS 5 – Operational Integration:** The technology is widely adopted and embedded in daily practice. Systems are interconnected, regulations are mature and enforced, and the benefits are measurable in efficiency, safety, or sustainability.
- **CRS 6 – Mature Ecosystem:** The technology is fully mainstreamed. Interoperability across borders or sectors is achieved, regulations are harmonized, and continuous innovation is supported by a resilient ecosystem. The country is seen as a leader and exporter of best practices.

The above adaptation of the TRL at the country level is domain-agnostic, but it can be considered as more targeted than the broader NRI and GRI metrics. Therefore, it can be readily applied to EAP countries regarding their deployment of emerging transport technologies such as EVs, CAVs, Big Data, and telematics. In the following section, the review of the state of the art of Chapter 2 is summarized, and enhanced with EU best practice examples, as well as a benchmarking of the selected EaP countries based on the CRS. An outline of key EU Directives and Regulations is presented in Appendix 2.

6.2. EU GOOD PRACTICE AND EAP BENCHMARKING

6.2.1. CONNECTED AND AUTOMATED VEHICLES

6.2.1.1. Key Laws and Regulations

The EU's **General Safety Regulation II** (GSR2) - formally Regulation (EU) 2019/2144 (European Parliament & Council of the European Union, 2019)[142,143,144] - serves as the foundation for mandating advanced safety technologies in new vehicles. Under this framework, all new vehicle types from July 2022, and every newly registered vehicle from July 2024, must be equipped with a suite of Advanced Driver Assistance Systems (**ADAS**), which include the following[145]:

- Advanced driver distraction warning
- Alcohol interlock installation facilitation
- Driver drowsiness and attention warning
- Emergency stop signal
- Event data recorder
- Intelligent speed assistance (ISA)
- Reversing detection
- Advanced emergency braking systems (AEBS) for M1 and N1 category vehicles
- Blind spot information systems and pedestrian / cyclist collision warning systems for M2, M3, N2 and N3 category vehicles
- Emergency lane keeping systems for M1 and N1 category vehicles
- Tyre pressure monitoring systems (TPMS) for all vehicle categories
- Enlarged pedestrian protection head impact protection zone for M1 and N1 category vehicles

Moreover, in preparation for the introduction of **autonomous/automated vehicles**, GSR II also specifies the fitment of the following features/systems to such vehicles[146]:

- Systems to replace the driver's control of the vehicle, including signaling, steering, accelerating, and braking.
- Systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area.
- Driver availability monitoring systems.
- Systems to provide safety information to other road users.
- Event data recorders for automated vehicles.

[142] European Parliament, & Council of the European Union. (2019). REGULATION (EU) 2019/2144 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles. Official Journal of the European Union, L4(726), 43–167. https://eur-lex.europa.eu/eli/reg/2019/2144/oj/eng
[143] https://www.tuvsud.com/en/knowledge-hub/articles/revision-of-the-eu-general-safety-regulation
[144] European Commission (2025 – In Press). Road safety thematic report – Vehicle Safety ADAS & Automation. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.
[145] https://ec.europa.eu/docsroom/documents/34588
[146] https://www.tuv.com/regulations-and-standards/en/eu-regulation-2019-2144-automotive-type-approval-general-safety-requirements.html#:~:text=%2D%20Intelligent%20speed%20assistance%20(ISA),on%20the%20link%20herein%20mentioned

- Harmonized format for the exchange of data, for example, multi-brand vehicle platooning

Collectively, these policies are designed to play a central role in advancing the EU's Vision Zero strategy, aiming to drastically reduce road fatalities and serious injuries.

6.2.1.2. EU Countries' Good Practice Examples

Germany has created a clear national legal framework to allow Level 4 operations in defined operational areas, including permit paths and operational requirements, which helps move testing toward limited commercial deployment while clarifying operator responsibilities[147].

The Netherlands enables wide practical testing on public roads and uses permissive, clearly documented testing regimes and national guidance to attract pilots and accelerate municipal rollouts of AV services[148].
Sweden has supported industry-led, city-scale pilots (for example Volvo's Drive Me in Gothenburg) that combine public authorities, research centers and OEMs to evaluate real-user acceptance and the urban traffic impacts of automated driving[149].

6.2.1.3. EaP Readiness Benchmarking

Based on the CRS framework outlined in section 6.1, with respect to the deployment of connected and automated vehicles:

- **Armenia is at CRS 1 – Initial Exploration**, as there is no meaningful deployment of connected or autonomous vehicle technologies yet, although infrastructure upgrades (like digital VMS and traffic data expansion) create potential foundations.
- **Georgia stands at CRS 2 – Emerging Testing,** given the SCOOT system in Tbilisi, dynamic signal controls, and partial ITS deployments that could support CAV integration in the long term.
- **Moldova also aligns with CRS 2,** with a centralized traffic management system in Chișinău and some VMS deployments, but no direct CAV testing initiatives. None of the three countries have yet engaged in regulatory frameworks or pilot trials for CAVs.

6.2.2. ELECTRIC VEHICLES (EVS]

6.2.2.1. Key Laws and Regulations

The EU has introduced mandatory national charging targets through the **Alternative Fuels Infrastructure Regulation (AFIR). EU law (EU 2023/851)** [150,151] now sets binding targets along the planned Trans-European Transport Network (TEN-T) and standardizes key user features: ad-hoc (no-contract) payment, clear price display, and kWh-based pricing on ≥50 kW chargers. In parallel, the EU finances charging infrastructure through the Alternative Fuels Infrastructure Facility (AFIF), part of the Connecting Europe Facility. This program awards hundreds of millions of euros in funding for chargers along the main transport corridors[152].

---

[147] https://www.bmv.de/SharedDocs/EN/Articles/DG/act-on-autonomous-driving.html
[148] https://www.government.nl/topics/mobility-public-transport-and-road-safety/self-driving-vehicles
[149] https://trimis.ec.europa.eu/project/drive-me
[150] https://transport.ec.europa.eu/transport-themes/clean-transport/alternative-fuels-sustainable-mobility-europe/alternative-fuels-infrastructure_en
[151] https://www.ampeco.com/blog/how-afir-reshapes-ev-charging-business/
[152] https://cinea.ec.europa.eu/news-events/news/transport-infrastructure-over-eur-424-million-eu-funding-boost-zero-emission-mobility-2024-04-10_en

The EU has set strict CO_2 standards for cars/vans. **New sales must achieve a 55% (cars) and 50% (vans) reduction in emissions by 2030** and reach zero emissions by 2035[153]. The new **EU Batteries Regulation (EU 2023/1542)** requires sustainable battery production, including carbon footprint reporting, recycled content targets, removability, and obligations for collection and recycling[154,155]. By the end of 2023, Europe had more than 630,000 public charging points, with the largest numbers in the Netherlands, Germany, and France.

6.2.2.2. EU Countries' Good Practice Examples

Most of Europe's countries with advanced economies have been accelerating or solidifying their EV market shares during the most recent time, with leading countries being Norway (achieving a dominating 96.4% market share), followed by Denmark (61%), Sweden (45%) and the Netherlands (~40%)[156].

- In the **Netherlands**, municipalities and industry work together on an open, interoperable charging network using common data protocols. The country has Europe's highest density of public chargers[157].
- **Germany** is building a nationwide fast-charging network (Deutschlandnetz)[158], to cover areas that lack stations. Germany also supports homeowners through grants that combine chargers, rooftop solar, and battery storage.
- **France** has a "right to plug" law that allows tenants and condominium owners to install chargers at their parking spots, even if building managers object[159]. France also runs a social leasing scheme that makes electric cars available for low- and middle-income households at €140 per month[160].
- **Spain** runs the MOVES III program, which provides subsidies for both purchasing electric vehicles and installing charging infrastructure. The program was extended until the end of 2025 with additional funding[161].
- **Portugal** offers straightforward purchase rebates of up to €4,000 per electric vehicle, with extra support for light commercial vehicles, all administered by a national environmental fund[162].
- **Denmark** uses a CO_2-based vehicle tax system. Electric vehicles benefit from lower registration and ownership taxes because of their zero emissions[163].

6.2.2.3. EaP Readiness Benchmarking

Based on the CRS framework of section 6.1, as regards the deployment of electric vehicles:

Armenia currently places at CRS 2 – Emerging Adoption, as electrification is starting but charging infrastructure remains limited, with only small-scale deployments.

Georgia is slightly ahead at CRS 3 – Early Expansion, due to growing EV imports (especially second-hand vehicles from Europe and the US) and some charging points, but still lacking national-scale strategy.

[153] https://natlawreview.com/article/eu-launches-call-evidence-revision-combustion-engine-and-vehicle-emissions
[154] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A32023R1542
[155] https://www.nortonrosefulbright.com/en/knowledge/publications/08e15e2c/new-eu-battery-regulation-focuses-on-sustainability-waste-management-and-due-diligence
[156] https://alternative-fuels-observatory.ec.europa.eu/general-information/news/european-ev-market-september-2024-country-country-deep-dive
[157] https://www.acea.auto/figure/interactive-map-correlation-between-electric-car-sales-and-charging-point-availability-2023-data/
[158] https://nationale-leitstelle.de/en/deutschlandnetz
[159] https://www.beev.co/en/blog/guides-voiture-electrique-et-bornes-de-recharge/les-obligations-dun-bailleur-pour-une-borne-de-recharge-en-france
[160] https://www.service-public.fr/particuliers/actualites/A16990?lang=en
[161] https://statzon.com/insights/ev-charging-points-europe
[162] https://alternative-fuels-observatory.ec.europa.eu/general-information/news/portugal-launches-2025-incentive-programmes-boost-zero-emission-mobility
[163] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/denmark/incentives-legislations

Moldova also falls under CRS 2, with modest EV uptake, scattered charging stations (mostly in Chișinău), and no nationwide infrastructure backbone. Across all three, policy support and incentives remain limited compared to EU frontrunners.

6.2.3. BIG DATA & AI

6.2.3.1. Key Laws and Regulations

The EU has introduced a comprehensive legal framework for data use in mobility through the **General Data Protection Regulation (GDPR)** and complementary acts such as the **European Data Governance Act (EU 2022/868)** [164] and the proposed **AI Act** [165] (EU 2024/1689, updates expected 2025). For AI-based safety applications, the AI Act classifies transport safety systems as “high-risk,” requiring conformity assessments, transparency obligations, human oversight, and post-deployment monitoring. In parallel, the UK GDPR (retained after Brexit) and the UK Data Protection Act 2018[166] impose similar safeguards for projects involving telematics, video analytics, or connected vehicle data in the UK market.

At the European level, the **ITS Directive** (EU 2010/40, revised 2023)[167] promotes the standardized exchange of traffic and safety data, supporting interoperability across Member States. Initiatives like the Common European Mobility Data Space are designed to facilitate secure, shared access to mobility data for research, public authorities, and industry, while ensuring compliance with privacy and cybersecurity rules. Additionally, **protocols such as the aforementioned AiRAP initiative and SRTI and RTTI services** within the ITS Directive aim to foster cooperations and streamline data collection and sharing.

6.2.3.2. EU Countries’ Good Practice Examples

i). **Big-data digital infrastructure:** The Netherlands collects and quality-controls multi-source traffic data in a National Data Warehouse (NDW) and exposes it via a single discovery/access point (NTM). This makes high-frequency data (speeds, flows, vehicle classes) available to modelers and suppliers under consistent formats. This can be used as the blueprint for a national mobility NAP [168]. In Spain (Catalonia), iRAP produce travel-weighted risk maps by fusing traffic counts, telematics and infrastructure audits to prioritize interventions where travel concentrates, which is a practical way to turn big data into road safety and transport investment decisions[169].

ii). **Predictive analytics for crash prevention:** In Sweden, pilots run by the City and OEMs (Volvo Drive Me in Gothenburg) combine vehicle telematics, HD maps and urban testbeds to validate VRU detection and collision-risk areas under real traffic, which is useful for validating VRU ML models in urban ODDs[170].

iii). **Intelligent infrastructure:** Italy’s Arena del Futuro test track (A35) demonstrates infrastructure innovation (dynamic charging, test track for connected systems) and is an exemplar for motorway-

[164] https://digital-strategy.ec.europa.eu/en/policies/data-governance-act
[165] https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai
[166] https://www.gov.uk/data-protection
[167] https://transport.ec.europa.eu/transport-themes/smart-mobility/road/its-directive-and-action-plan_en
[168] https://english.ndw.nu
[169] https://irap.org/2024/12/catalonia-risk-mapping-results-released-for-23rd-year/
[170] https://www.drivesweden.net/sites/default/files/2021-11/ad_aware_traffic_control_1_2_and_3_final_report_v1.0_0.pdf

scale testbeds and public-private partnerships[171]. Lessons learned from the test track can be integrated into infrastructure-to-vehicle technology, reducing respective risks.

iv). **Real-time monitoring, enforcement & traffic control:** In the Netherlands, the City of Amsterdam and national smart-mobility programmes provide policies of smart traffic management, as well as open testbeds and data policies for pilots. It should be noted that Amsterdam has recently paused some smart-lights rollout due to reasons of privacy, which illustrates the need for early DPA engagement and transparent data governance[172].

v). **Real-time emergency response & incident reporting:** In Spain, Barcelona's integrated CIVICAT model fuses multiple feeds (sensor, camera, crowdsourced) to speed incident validation and EMS routing. Fusion can be used to reduce false alarms and prioritise high-severity incidents[173]. Various operational drills have been conducted in Finland concerning test AI scenarios with Emergency Medical Services & Traffic Management Centres to reduce traffic- and heating-related emissions. The Helsinki Jätkäsaari Mobility Lab has used AI to enhance transport flows with a generic algorithm controlling traffic lights, leading to 15-30% better traffic flows[174].

6.2.3.3. EaP Readiness Benchmarking

On the basis of the CRS framework of section 6.1, as regards the deployment of Big Data & AI applications:
Armenia is positioned at CRS 3 – Early Expansion, as it has begun deploying real-time crash analytics, geospatial mapping, and smart crossroads, showing first practical use of AI/Big Data in road safety.

Georgia sits at CRS 2 – Emerging Testing, with real-time data flows from private services (Google/Yandex) and some central traffic management but limited public access or structured AI use in road safety.

Moldova is at CRS 3, due to real-time data collection in Chișinău, traffic/weather monitoring platforms, and centralized traffic signal control—indicating a stronger initial institutional framework compared to Georgia.

6.2.4. DRIVER TELEMATICS

6.2.4.1. EU Countries' Good Practice Examples

Italy leads Europe in telematics insurance, with millions of vehicles fitted with black boxes by major insurers such as Unipol and Generali. These systems provide usage-based insurance and safety feedback, making Italy a benchmark for large-scale consumer adoption of telematics[175].

In **Germany** and **Greece**, insurers like HUK-Coburg and ERGO offer app-based telematics programs such as Telematik Plus/OSeven, which reward safe driving with premium discounts[176,177]. The programs also generate anonymised safety data that can inform broader road safety policy.

---

171 https://www.electrichybridvehicletechnology.com/news/charging-technology/revolutionary-road-for-wireless-electric-car-charging-completed-in-italy.html
172 https://amsterdamsmartcity.com/updates/project/smart-traffic-management
173 https://international.fhwa.dot.gov/travelinfo/barcelona.cfm
174 https://ai4cities.eu/cities/helsinki
175 https://www.berginsight.com/europe-and-north-america-reached-304-million-active-insurance-telematics-policies-in-2022
176 https://www.icmif.org/icmif-undrr/huk-coburg-telematics-for-driver-safety-and-sustainability-germany
177 https://oseven.io/

6.2.4.2. EaP Readiness Benchmarking

Based on the CRS framework of section 6.1, as regards the deployment of driver telematics:

- **Armenia reaches CRS 3 – Early Expansion**, with integrated public transport telematics, smart payment systems, and pilot smart mobility schemes, providing a foundation for broader driver telematics.
- **Georgia is slightly more advanced at CRS 4 – Scaling Integration**, thanks to GPS-tracked buses, live arrival systems, adaptive signals, and integration with central control centers, showing a mature rollout in the urban core.
- **Moldova is at CRS 3**, where telematics exist in public transport and apps, but coverage is still basic and largely confined to Chișinău, without strong nation-wide deployment.

6.2.5. SUMMARY

The following Table 6.1 summarizes the current national technological readiness, as expressed by the CRS placement of the selected EaP countries for the four examined technological pillars.

Table 6.1: Country Readiness Scale (CRS) for Emerging Transport Technologies

Technology	Armenia	Georgia	Moldova
EV Adoption	CRS 2 – Emerging Adoption (early uptake, few chargers)	CRS 3 – Early Expansion (imports growing, scattered charging)	CRS 2 – Emerging Adoption (modest uptake, Chișinău focus)
CAV Readiness	CRS 1 – Initial Exploration (no CAV pilots, only infrastructure upgrades)	CRS 2 – Emerging Testing (SCOOT, adaptive signals, ITS in Tbilisi)	CRS 2 – Emerging Testing (traffic center, VMS, but no CAV pilots)
AI / Big Data in Safety	CRS 3 – Early Expansion (crash analytics, smart crossroads)	CRS 2 – Emerging Testing (private data feeds, limited AI use)	CRS 3 – Early Expansion (real-time traffic & weather monitoring, centralized control)
Driver Telematics	CRS 3 – Early Expansion (smart crossroads, public transport tracking, payment integration)	CRS 4 – Scaling Integration (GPS buses, SCOOT signals, integrated control)	CRS 3 – Early Expansion (basic tracking, Chișinău-based apps)

6.3. ROAD MAP FOR TECHNOLOGY DEVELOPMENT IN EAP COUNTRIES

On the basis of the above, Table 6.2 provides **a roadmap summarizing the required next technical steps** to advance CRS per country and technology for the short, medium and long term. To ensure a realistic perspective, each term considers a 1-step advancement in the CRS scale.

Table 6.2: Future Roadmap for Short, Medium and Long-Term Technology Adoption per Country

EV Adoption Roadmap			
Country	**Short Term (+1 CRS from present)**	**Medium Term (+2 CRS from present)**	**Long Term (+3 CRS from present)**
Armenia	Expand EV charging hubs in Yerevan and interurban corridors.	Launch national EV purchase incentives and import tax benefits.	Establish nationwide fast-charging corridors and grid upgrades for EV scaling.
Georgia	Densify EV charging network beyond Tbilisi.	Develop comprehensive EV policy (subsidies, urban charging mandates).	Scale charging infrastructure across highways and integrate with renewable grid.
Moldova	Deploy more chargers outside Chișinău.	Offer EV tax incentives and introduce green fleet policies for public transport.	Expand national charging backbone across interurban routes, integrate with EU TEN-T.
CAV Readiness Roadmap			
Country	**Short Term (+1 CRS from present)**	**Medium Term (+2 CRS from present)**	**Long Term (+3 CRS from present)**
Armenia	Pilot adaptive traffic signals in Yerevan.	Develop small-scale CAV testing zones with infrastructure support.	Deploy CAV-ready corridors with 5G and V2X infrastructure.
Georgia	Expand SCOOT system beyond Tbilisi.	Pilot CAV corridors in urban areas with ITS integration.	Scale nationwide CAV readiness program and enable autonomous fleet pilots.
Moldova	Enhance Chișinău traffic center with adaptive intersections.	Pilot CAV-ready intersections and integrate V2X pilots.	Develop CAV-ready regional corridors and national strategy for autonomy.

AI / Big Data in Road Safety Roadmap			
Country	**Short Term (+1 CRS from present)**	**Medium Term (+2 CRS from present)**	**Long Term (+3 CRS from present)**
Armenia	Broaden crash and traffic analytics with AI support.	Integrate weather, pavement, and traffic data into predictive models.	Build a national AI-driven risk prediction platform for traffic safety.
Georgia	Open traffic management and private feeds for public use.	Develop unified data hub combining multimodal, crash, and weather inputs.	Deploy AI-based national safety platform with real-time decision support.
Moldova	Expand Chișinău traffic center data feeds and analytics.	Integrate regional data (traffic, crashes, weather) into a national hub.	Scale into nationwide AI-powered transport safety and planning platform.

Driver Telematics Roadmap			
Country	**Short Term (+1 CRS from present)**	**Medium Term (+2 CRS from present)**	**Long Term (+3 CRS from present)**
Armenia	Expand smart crossroads and tracking to bus fleets.	Integrate telematics with safety feedback apps for drivers.	Scale national telematics across private fleets and public transport.
Georgia	Extend GPS tracking and telematics to regional transit.	Launch integrated driver behaviour monitoring and safety feedback systems.	Embed telematics in national regulations and promote cross-border data standards.
Moldova	Expand basic tracking beyond Chișinău to regional fleets.	Pilot telematics-based insurance and safety programs.	Roll out nationwide telematics integration across transport sectors.

Moreover, the following Figures summarize the **technology adoption actions for readiness progression in each domain** in all selected countries.

Figure 6.1: Road Map for CAV Technology Readiness Progression in the EaP Region

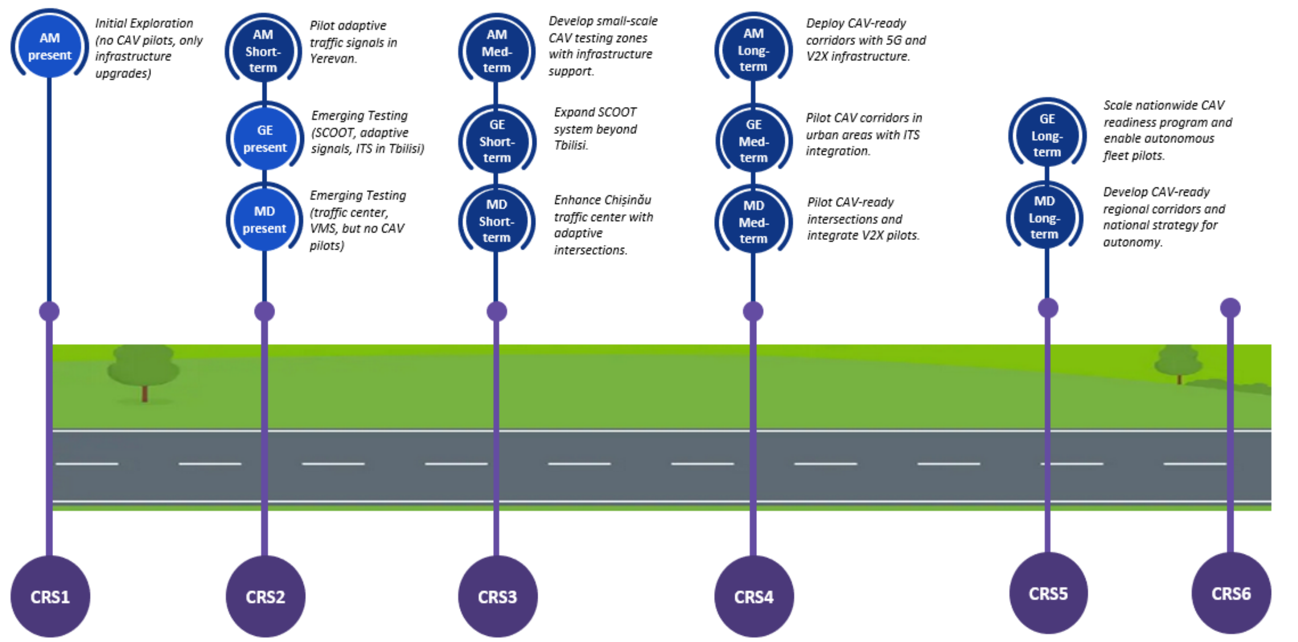


Figure 6.2: Road Map for EV Technology Readiness Progression in the EaP Region

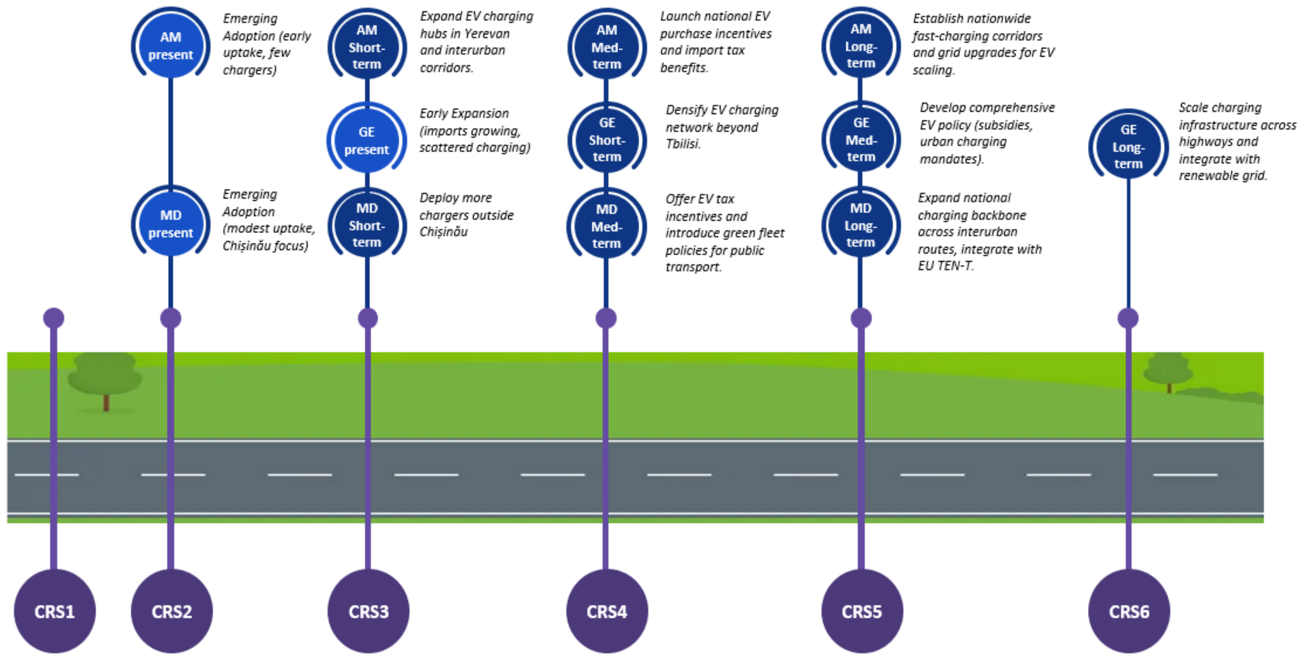


Figure 6.3: Road Map for Big Data & AI Technology Readiness Progression in the EaP Region

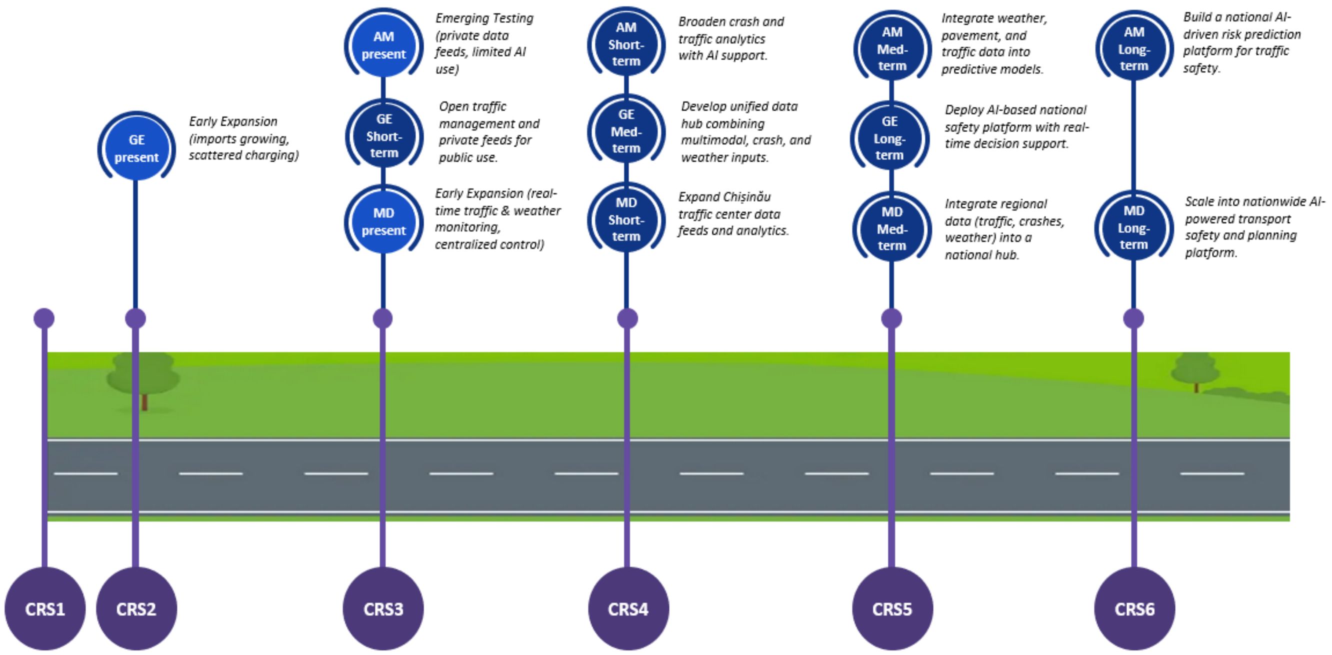
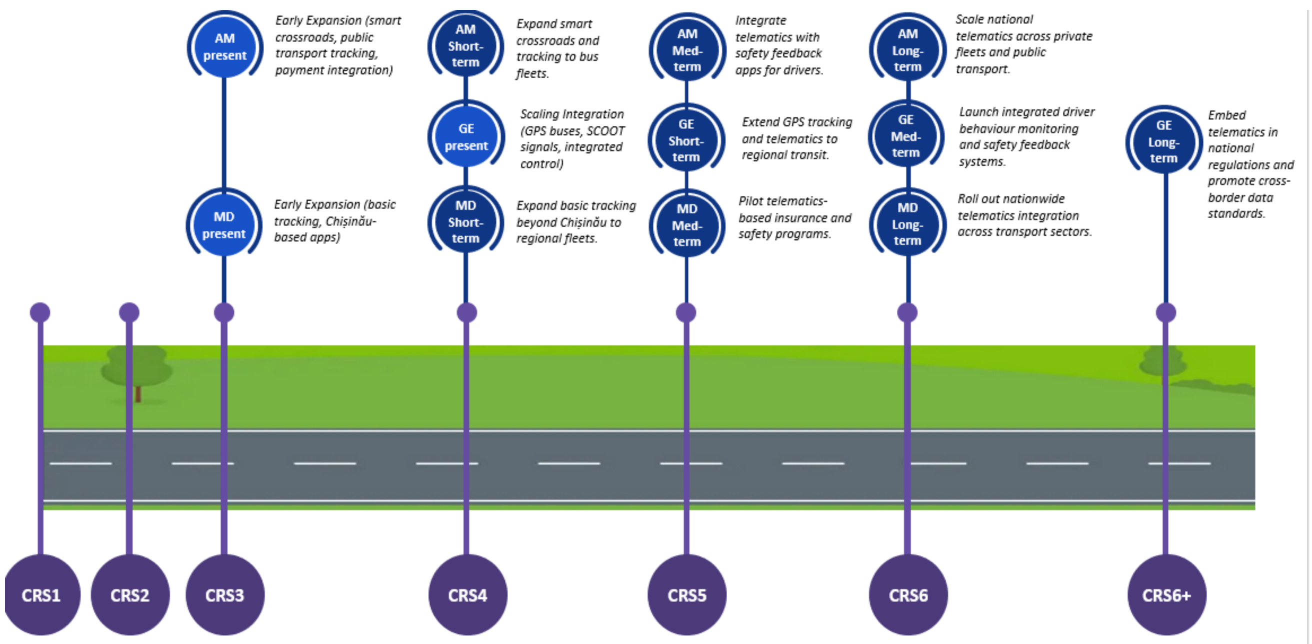


Figure 6.4: Road Map for Driver Telematics Technology Readiness Progression in the EaP Region



6.4. FINAL RECOMMENDATIONS FOR EAP COUNTRIES

In the EaP region, road safety progress has been slow, and recent road fatality figures show stagnation, and even an increase in traffic fatalities. Armenia, Georgia and Azerbaijan have shown increased traffic fatalities on 2022-2023 compared to previous years, and only Moldova shows a continuous decreasing trend. At the same time, VRUs still have a disproportional burden of casualties compared to motorists; for instance, the share of pedestrians among the total traffic fatalities in the EaP countries ranges between 27% (Georgia) to 45% (Azerbaijan), with an increasing trend between 2018-2023 in several EaP countries.

In this context, road safety projects supported by international organisations emphasize rehabilitation and safety improvements on key corridors, including pavement upgrades and installation of safety barriers, which involve regular inspections and quality control. However, there is no specific information indicating that road safety audits and inspections are yet fully aligned with technology developments, e.g. sensors and units for V2I communication and AV navigation, for continuous real-time monitoring of infrastructure state or highly precise digital mapping of road infrastructure. At the same time, vehicle fleets are old, and newly registered vehicles are largely imported in the region, without any specific standards regarding the age, environmental footprint and technical condition of the imported vehicles. Some EaP countries are making efforts for the establishment of technology solutions to improve road safety, by means of traffic management centers, automated traffic enforcement systems, smart intersections / crosswalks etc. However, in most cases these efforts are localized and in pilot phases, while delays due to financial or administrative difficulties are not uncommon.

While new technologies bring important potential for further road safety improvements, **they should not be perceived as a panacea for road safety problems**. There are several road safety challenges that can be effectively addressed by means of infrastructure design (including VRU inclusive design), audits, maintenance and inspections, as well as speed enforcement. Countries should **prioritize basic Safe System interventions** and gradually integrate road safety technologies.

At the same time, the level of institutional and regulatory readiness for road safety and sustainability technologies is satisfactory. Most countries have strategies and plans for digitalization, including road safety and mobility plans that include technology and electrification goals. Moreover, cybersecurity, data protection and liability issues are proactively regulated in most countries. Therefore, **there are several opportunities for accelerated technology penetration, once financial, technical and operational barriers are addressed.**

6.4.1. AT THE INSTITUTIONAL LEVEL

i). **Consolidating regulatory readiness through central coordination and intersectoral cooperation**: as mentioned above, most EaP countries have laws and regulations regarding the management of technology and its risks; it is important to consolidate these regulations by means of central coordination and ongoing intersectoral collaboration, so that technology is deployed in a seamless and responsible way across sectors.

ii). **Capacity building on implementation of regulations**: While emerging regulations emphasize data systems safety, cybersecurity, and data governance / management, there is currently little experience in the region with implementing such formal guidelines to address specific technology-related concerns, such as road user privacy, unauthorized access etc. Adopting standard EU and international acts, regulations and directives (e.g. on data protection and privacy, AI etc.) will facilitate implementation and knowledge transfer from European countries.

iii). **Investment in human capital**: Countries should invest in professional education in the fields of data science, digitalization, ICT and their management (including security risks), in order to ensure knowledge and capacity at the middle level of government, institutions and industry. At the same time, investment in engineering and technology management education will provide a new generation of professionals that may accelerate adoption and acceptance of innovation in national transport projects, as well as lead their implementation.

iv). **Transport infrastructure financial investments with an eye to the future**: countries should identify synergies and opportunities within existing infrastructure projects for the introduction of technological and digital road safety solutions. While the development and upgrade of the physical infrastructure is a reasonable priority in the EaP context, the incorporation of low-cost technology solutions within planned projects can lead to "quick wins" in terms of technology-related road safety gains (see also point (ix) below). Moreover, integration with other sectoral technologies, e.g. energy grids, urban logistics, transport terminals etc. should be carried out in a proactive way, already from the design / road safety audit phase. Particular focus should be placed on the **accommodation of vulnerable road users (pedestrians, cyclists) as well as new micromobility modes (e.g. e-bikes, e-scooters)**.

v). **Incentivizing innovation with participation of the private sector**: several technology solutions from those mentioned in (iv) above can be implemented by small "disruptive" and dynamic tech companies, startups etc. Governments should facilitate and incentivize their participation in transport projects, by creating a healthy and competitive environment.

vi). **Regulating vehicle standards**: EaP countries should adopt the core UN Vehicle Regulations as regards basic safety features, technical inspections etc. In the medium to long-term, it is recommended that they harmonize their vehicle safety and CAV regulations with advanced frameworks like the EU Vehicle Safety Regulation (EU) 2019/2144 or UNECE WP.29 AV rules, creating a regulatory background for ADAS / CAV deployment.

6.4.2. AT THE TECHNICAL LEVEL

i). **Connectivity as a priority**: EaP countries should accelerate 5G deployment, which is crucial for many transport innovations. Particular care should be given to digital infrastructures and networks coverage in rural areas, where critical road safety issues prevail.

ii). **Energy independency and efficiency**: countries should take steps to minimize energy dependency and develop resilient networks, in order to accommodate future transport technologies – which can also be sensitive to disruptions due to weather, energy or cyber threats.

iii). **Proactive road and transport infrastructure planning**: EaP countries should include future outlook for digital infrastructures and machine-readable road equipment in their current network development and upgrade projects. In urban areas, particular focus should be put on inclusive designs that will allow for **technology solutions to cover pedestrians, cyclists, micromobility users** etc. Other such synergies may concern the embedding of pavement condition monitoring sensors within standard road maintenance, the use of existing traffic enforcement cameras for image processing e.g. with the aim of detecting traffic conflicts at major intersections, or the development of driver telematics through mobile phone apps. These interventions are based on light and affordable equipment and can be made operational largely through software / algorithmic solutions.

iv). **Electrification as a pathway to road safety:** EVs available are already equipped with most basic ADAS and V2I features that have been proved to have significant road safety benefits. While the deployment of higher-level AVs is realistically only a long-term vision, many of the expected road safety benefits from advanced vehicle technologies can be achieved through EVs. Given the high acceptance and popularity of EVs among stakeholders and citizens in most countries, and the existing pipelines of incentives in all EaP countries, there is an opportunity to address road safety and sustainability jointly but accelerating the electrification strategies of the countries.

6.4.3. AT THE OPERATIONAL LEVEL

i). **A routine of road infrastructure safety management:** countries should adopt and implement the EU directive 2008/96/EC on road infrastructure safety management (RISM), which outlines the steps and procedures required for managing safety along the whole lifecycle of infrastructures, by implementing procedures for impact assessments, audits, and safety inspections. It specifically addresses the integration of technology in road infrastructure to enhance safety, including the use of road safety performance indicators (SPIs or KPIs) and the consideration of emerging technologies like automated vehicles. For example, the directive:

- Mandates a comprehensive assessment of the entire road network to identify potential safety risks.
- Promotes the use of indicators, such as the percentage of drivers complying with speed limits or the proportion of vehicles meeting safety standards, to help in proactively identifying hazards and guiding safety management efforts.
- Recognizes the impact of automated vehicles and the need to address the challenges they pose to road safety, particularly in mixed traffic conditions.
- Facilitates the sharing of knowledge and best practices among member states, including the adoption of proven road safety technologies.
- Encourages countries to invest in safer and more sustainable transport networks through national recovery and resilience plans.
- Establishes a framework for accessing in-vehicle data for accident research and roadworthiness purposes, while respecting the General Data Protection Regulation. Recognizes the interdependency of vehicle technology and infrastructure, such as the need for clear road markings to support lane-keeping assistance systems.

ii). **Training among professionals:** currently, there is a moderately strong command of data and technology-based road safety within key agencies. However, broader scaling is still in progress. Many road and enforcement agencies are still building internal expertise—in part due to limited human resources and reliance on external support. It is recommended that dedicated training is provided to hands-on professionals dealing with transport technologies, by means of (but not limited to):

- Specialized graduate training—via police, public administration and internal affairs academies and education institutes

- International workshops on technical standards, including EU standards such as RISM, GDPR etc.
- Dedicated training pathways like iRAP accreditation for road engineers and crash-data analysts – which may include training on AI, Big Data and other technology applications relevant to road assessment (e.g. AIRAP).
- Training aimed at operational readiness for database systems, trauma registries, speed enforcement technology and speed camera video data processing, infrastructure star-rating (physical and digital) etc.

APPENDIX 1. SURVEY QUESTIONNAIRE

QUESTIONNAIRE ON TECHNOLOGY READINESS FOR ROAD SAFETY & SUSTAINABILITY IN THE EAP REGION

As road safety continues to be a major global health and sustainability challenge, technology developments are fast emerging, aiming to essentially improve road safety and accelerate traffic fatality reductions and environmental improvements. These technologies and tools concern (but are not limited to) advanced driver assistance systems (ADAS), automated vehicles (AVs), electric vehicles (EVs), vehicle connectivity (V2I), Big Data collected from various sensors, Artificial Intelligence (AI) applications for proactive and/or real-time road safety management, driver telematics, etc. However, these technologies and applications require a certain level of technology readiness from an institutional, technical and societal perspective. There are considerable inequalities among countries in their capacity and readiness to benefit from these technological developments.

This survey aims to assess the technological readiness for road safety and sustainability related technologies in the EaP region, in order to highlight opportunities, challenges, and good practice examples. The survey is addressed (but not limited) to representatives of: Ministry of Transport, Ministry of Interior/ Traffic Police, Road Safety Lead Agency, Road Authorities / Road Operators, Road Safety academics.

Please answer this questionnaire in the best of your knowledge and experience. There is no liability associated with the information provided or data. The information and data shared in this questionnaire will be handled only by the transport expert in charge of the study. A report will be published with the results of this survey. This list of names and affiliations of the questionnaire respondents may be published in the Appendix of the report, however the information presented in the report will not be associated with a specific person.

A.1. GENERAL TECHNOLOGY READINESS

i. Is there a **national strategy** on technology adoption, digital transformation, etc.?
(Yes / Partially / No)

Please describe and attach a report / provide a URL if available.
Please indicate briefly if this strategy includes road safety and sustainable transport technologies explicitly.

ii. Is there a **legal framework for technology adoption** e.g. covering data privacy, inclusiveness, etc.?
(Yes / Partially / No)

Please describe and attach a report if available
Also describe if the country’s legal framework align with international data privacy standards (e.g. EU-GDPR).

iii. Is there a national and/or international **investment in transport / road safety technology**, e.g. programme, funding etc.?
(Yes / Partially / No)

Please describe

iv. What is the (approximate) **yearly number of University graduates** in your country in data science, AI, robotics or similar?

Please describe

v. What is the (approximate) **yearly number of University graduates** in your country in transportation engineering, road safety or similar?

Please describe

vi. In your experience, what is the **level of knowledge and operational capacity in government and transport / road operators** with road safety technologies?

e.g. through MSc degrees (or higher) of key administrative & management staff on data science, innovation management, management of technology or similar; through dedicated training; through hands-on experience with managing using such technologies etc.

Please describe

vii. Are there any **formal collaborations in place between government, industry and / or academia** in the field of road safety technology?
(Yes / Partially / No)

Please describe and provide examples of successful collaboration projects including URL/reference if available

viii. Are there **Small-Medium Enterprises (SMEs)** or other companies with an emerging role in deploying road safety technologies?
(Yes / No)

Please describe and give examples, or a URL

A.2. VEHICLE SAFETY & AUTOMATION

i. Are key ADAS systems (e.g., Lane Keep Assist, Automatic Emergency Braking, Intelligent Speed Assistance) compulsory for new vehicles in your country, in line with EU Vehicle Safety Regulation (EU) 2019/2144? (Yes / Partially / No)

Please describe

ii. Is there a **strategy, action plan on the deployment of automated vehicles** in the country? (Yes / Partially / No)

Please describe and attach a report if available

iii. Is there a **specific policy or regulation in place** or under preparation for the deployment of automated vehicles in the country? (Yes / Partially / No)

Please describe and attach a report if available

iv. Are there any **pilot projects on testing automated vehicles** in the country? (Yes / No)

Please describe and attach a report if available, or provide a URL

v. What is the **coverage of 4G/5G networks** in the country, expressed as percentage of land area covered?

Please describe

vi. Are there **regular road safety inspections** for road markings, signs and pavement conditions, which would be necessary for AV navigation? (Yes / Partially / No)

Please describe

vii. Are there formal **guidelines for road inspection and maintenance**? (Yes / Partially / No)

Please describe and attach a report if available

viii. Are there any **digital infrastructure elements** already available on the road network?
For example, are V2I systems foreseen in current / future road design projects, is machine-readable signage installed or foreseen?
(Yes / Partially / No)

Please describe

ix. In your experience, what are the main **institutional or regulatory barriers** in the deployment of AVs in the country?

Please describe

x. In your experience, what are the main **technological and technical barriers** in the deployment of AVs in the country?

Please describe

xi. Are there any **ride-sharing[178] services** actually implemented in the country?
(Yes / Partially / No)

Please describe and attach a report if available, or provide a URL

xii. Is there any information about the **acceptance of/ trust in AV technologies** in your country? E.g., through a survey on attitudes, or investigation of consumer preferences

Please describe and attach a report, or provide a reference if available

[178] The practice of sharing car trips, typically through an arrangement in which drivers of usually privately owned cars who wish to offer rides and passengers who wish to obtain rides use a network (such as one accessed through an app or a website) to coordinate the sharing of individual car trips, for which the passengers pay a fare.

A.3. ELECTRIC VEHICLES & SUSTAINABILITY

i. Is there a **strategy/action plan on the deployment of electric vehicles** in the country? Or a broader programme towards green energy & innovation, or similar?
(Yes / Partially / No)

Please describe and attach a report if available

ii. Is there a specific **policy or incentive (e.g. economic, environmental etc.)** in place or under preparation for the acceleration or promotion of EVs in the country?
(Yes / Partially / No)

Please describe

iii. What is the **share of EVs in the vehicle fleet** in your country? Please fill in the Table below.

	2018	2019	2020	2021	2022	2023
Total number of registered vehicles						
Number of passenger cars (new registration)						
Number of EVs (new registration)						

iv. How many **EV charging stations** are installed in the country, per road type (highway, interurban, urban)? Please specify separately for different charging speeds (slow, fast, ultra-fast) if possible.

Please describe and attach a report if available, or provide a URL

v. What is the average **charging speed** in these stations?

Please describe

vi. What is the **price difference** between an EV and the same vehicle model with a regular combustion engine in your country?

Please provide some indicative examples

vii. In your experience, what are the main **institutional or regulatory barriers** in the deployment of EVs in the country?

Please describe

viii. In your experience, what are the main **technological and technical barriers** in the deployment of EVs in the country?

Please describe

ix. Is there any information about the **acceptance of/ intention to use EV technologies** in your country? E.g., through a survey on attitudes, or investigation of consumer preferences.

Please describe and attach a report if available, or provide a reference

A.4. BIG DATA, DIGITALIZATION & AI APPLICATIONS

i. Are there **data standards in place in the public sector** or guidelines for data governance in your country, or similar?

Please describe and attach a report if available

ii. Are there **high-definition digital maps**[179] at country / city level?

Please describe and provide a URL if available

iii. Is there **real-time traffic information** available to road operators?

- How is the data collected? From loop detectors, traffic cameras?
- What is the density of sensors?
- What is the processing latency[180] of data collected?

Please describe and attach a report if available

iv. Are there **traffic management centers** for main interurban or urban roads?

- Are there multiple sources of data (e.g. traffic, weather, speed) collected and processed?
- Is the data used for real-time information provided to drivers?
- Is the data used for congestion / access management?
- Is the data used for incident / crash detection?

Please describe and attach a report if available

v. Are there technology applications or systems in place to **monitor driver behaviour**, e.g. speeding, harsh braking, mobile phone use while driving?

- What sensors are used? Smartphones, vehicle GPS data, in-vehicle cameras?
- Do the drivers receive any feedback on their behaviour or fine for their violations?

Please describe and attach a report if available

vi. Are there **data centers from big tech-companies** established in your country?

[179] A high-definition map (HD map) is a highly accurate map used primarily in the field of autonomous driving, containing details not normally present on traditional maps. HD maps are often captured using an array of sensors, such as LiDARs, radars, digital cameras, and GPS, and they can also be constructed using aerial imagery.

[180] Data latency refers to the time delay between when data is sent for use and when it produces the desired result.

Please describe and attach a report if available

vii. What provisions are in place for **cybersecurity and data privacy** – including drivers' personal data? E.g. EU-GDPR regulation or similar is adopted?

Please describe and attach a report if available

viii. What other **ITS applications exist in interurban roads**?

- Variable message signs?
- Variable speed limits?
- Dynamic Speed Display signs?
- Speed cameras?
- Other?

Please describe and provide a report / reference if available

ix. What other **ITS applications exist in urban roads**?

- Variable message signs?
- Driver information?
- Optimization of traffic signals?
- Public transport telematics?
- Other?

Please describe and provide a report / reference if available

x. What **ITS applications exist to support the safety of pedestrians or cyclists**?

- Intelligent pedestrian crossings?
- Cyclist detection systems?
- Pedestrian flow analysis systems?
- Other?

Please describe and provide a report / reference if available

A.5. KEY ROAD SAFETY FIGURES

Please fill in the Table below with the **number of fatalities per road user, vehicle or crash type**.

Please indicate the official source of provided data (e.g., National Bureau of Statistics, Police, National Road Safety Council, etc.). If data is not available, incomplete or considered unreliable, please explain briefly any known issues or challenges regarding data quality or availability. If available, please include a URL or attach a file.

	2018	2019	2020	2021	2022	2023
Total traffic fatalities						
On urban roads						
On interurban roads						
On motorways						
At junctions						
Passenger car occupants						
Pedestrians						
Rear-end collision						
Frontal collision						
Side collision						
Single-vehicle						
In vehicles >10 years old						
In vehicles <5 years old						

A.6. COUNTRY EXPERIENCES WITH ADVANCED ROAD SAFETY AND SUSTAINABILITY TECHNOLOGIES

Please outline **any additional projects, studies or initiatives in your country**, including ITS or other systems using AI to process Big Data for road maintenance, traffic management or other road safety purposes.

Please provide a URL with more information, or a reference to a report, if available (incl. reports in native language)

A.7. TECHNOLOGY ACCEPTANCE AND TRUST BY COUNTRY STAKEHOLDERS

Please answer the following questions with **your opinion and perception of road safety technologies, <u>from the viewpoint of your professional position in the transportation sector in your country</u>**. More specifically, please indicate (with an X inside the related call) to what extent you agree with the following statements.

	Disagree	Somewhat disagree	Neutral	Somewhat agree	Fully agree
Automated vehicles will enhance the overall transportation system					
Automated vehicles will improve road safety					
Current ADAS systems are sufficient to improve road safety					
I would find it pleasant to be a driver or passenger in automated vehicles					
In general, I would trust fully automated vehicles					
I trust automated vehicles to avoid obstacles					
I trust automated vehicles to interact safely with pedestrians and cyclists					
Electric vehicles will enhance the overall transportation system					
Electric vehicles will improve the environment by reducing pollution					
I would purchase an electric vehicle if I could afford one					
AI has the potential to enhance the transportation system					
AI can make traffic more efficient					
AI can make roads safer					

	Disagree	Somewhat disagree	Neutral	Somewhat agree	Fully agree
Telematics for monitoring driver behaviour can improve safety					
Road operators should use AI to manage the road networks					
Government should use AI to improve transportation systems					
AI is a black box not allowing for informed decisions in transport					
In general, I would trust AI predictions of traffic and incidents					
I trust AI to prevent road collisions in real-time					
I trust AI to detect road safety problems					
I would use AI applications in my daily tasks regarding transport management					
I would use only AI applications that explain their outcomes					
I am concerned about data privacy and security in AI applications					
I am concerned about the technological and operational capacity needed to implement AI					

Please provide here any additional comments or remarks that you think could help with this study

THANK YOU FOR your **PARTICIPATION! YOUR CONTRIBUTION IS MUCH APPRECIATED!**

APPENDIX 2. KEY EU DIRECTIVES AND REGULATIONS

General Data Protection Regulation (GDPR) - Regulation (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data - https://eur-lex.europa.eu/eli/reg/2016/679/oj/eng

European Data Governance Act (EU 2022/868) of 30 May 2022 on European data governance - https://eur-lex.europa.eu/eli/reg/2022/868/oj/eng

AI Act - EU 2024/1689, (updates expected 2025) of 13 June 2024 laying down harmonised rules on artificial intelligence - https://eur-lex.europa.eu/eli/reg/2024/1689/oj/eng

ITS Directive - (EU) 2023/2661 of 22 November 2023 amending Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport - https://eur-lex.europa.eu/eli/dir/2023/2661/oj/eng

General Safety Regulation II (GSR2) - (EU) 2019/2144 of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles. Official Journal of the European Union, L4(726), 43–167. - https://eur-lex.europa.eu/eli/reg/2019/2144/oj/eng

Alternative Fuels Infrastructure Regulation (AFIR) - (EU) 2023/1804 of 13 September 2023 on the deployment of alternative fuels infrastructure - https://eur-lex.europa.eu/eli/reg/2023/1804/oj/eng

EU 2023/851 of 19 April 2023 - amending Regulation (EU) 2019/631 as regards strengthening the **CO2 emission performance standards** for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition - https://eur-lex.europa.eu/eli/reg/2023/851/oj/eng

EU Batteries Regulation (EU 2023/1542) of 12 July 2023 concerning batteries and waste batteries - https://eur-lex.europa.eu/eli/reg/2023/1542/oj/eng

ADR Directive - 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods - https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008L0068

PTI Directive - 2014/45/EU of the European Parliament and of the Council of 3 April 2014 on periodic roadworthiness tests for motor vehicles and their trailers - https://eur-lex.europa.eu/eli/dir/2014/45/oj/eng