ERTICO
ITS EUROPE

ERTICO Perspectives on Artificial Intelligence in the Domain of Transport & Mobility

White Paper
15 October 2024

Executive Summary

This White Paper provides a first examination of the opportunities, challenges, and future outlook of Artificial Intelligence (AI) in the European mobility sector. It offers insights into the transformative role of AI in enhancing traffic management, advancing automotive technologies, improving public transportation systems, and optimising logistics and supply chains. It also explores the potential of related applications, including generative AI and large language models, and how they can support compliance with European Unions (EU) policy targets.

The integration of AI within mobility holds promise for increasing efficiency, safety, and sustainability. However, significant challenges remain, particularly around compliance with existing regulations, addressing job skill requirements, safety and security concerns, ethical considerations, and data privacy. This paper aims to inform policymakers and stakeholders about key lessons from implemented AI-driven projects and further proposes the role in contributing to future strategies.

In terms of governance, the paper highlights the EU regulatory frameworks, such as the EU AI Act, which classifies AI systems based on risk. High-risk systems, particularly those used in critical infrastructure like traffic control centres, are subject to stringent regulation. It also details the EU's ongoing efforts to balance innovation with the need to safeguard fundamental rights and maintain ethical standards.

For policymakers, we emphasise the importance of enhancing the AI policy framework, supporting research and innovation, and fostering international collaboration. We also project future trends in AI adoption, identifying emerging technologies that will shape the sector and considering the implications for stakeholders, including vulnerable road users.

The White Paper includes an annex detailing ERTICO's relevant activities, platforms and other initiatives, which play key roles in advancing AI's role in the mobility sector. These initiatives provide a framework for further AI integration and highlight the importance of coordinated efforts across sectors.

Finally, this paper does not intent to list the complete set of possible actions and activities in this domain and should therefore be considered as first perspectives for deeper discussions and interactions with European Union stakeholders.

About ERTICO – ITS Europe: Founded in 1991 by 15 industry leaders and the European Commission, ERTICO – ITS Europe is a public-private partnership with close to 120 members from eight sectors across the mobility ecosystem. ERTICO facilitates and promotes innovation, research and deployment of new Intelligent Transport Systems (ITS) and smart and sustainable mobility solutions. ERTICO embodies thought leadership and stakeholder engagement through various activities, including European co-funded projects, innovation platforms, and ERTICO-led initiatives such as the ERTICO Academy and City Moonshot. ERTICO has organised over 40 ITS European and World Congresses, contributing to shaping the future of ITS and providing networking opportunities for the wider community.

Table of Contents

1. Introduction

1.1. Background and Context

The integration of Artificial Intelligence (AI) technologies within the mobility sector has garnered significant attention in recent years. As transportation systems evolve to meet the demands of growing urban populations and increasingly complex logistics networks, AI presents a transformative opportunity to enhance efficiency, safety, and sustainability.

The European Union (EU), with its commitment to fostering innovation and addressing societal challenges, stands at the forefront of this technological revolution. Recognising the potential of AI to revolutionise transportation and mobility, the European Commission has prioritised the development of regulatory frameworks and initiatives to support responsible AI adoption across member states. EU stakeholders can build on large data sets available in the mobility and Intelligent Transport Systems (ITS) context in standardised and open formats (e.g. TN-ITS, Datex II, Netex, etc.) and on the legal framework in terms of data privacy, which enables their use in AI-based software and systems.

1.2. Purpose of the White Paper

This informative paper aims to provide ERTICO's perspectives of the current landscape of AI in the mobility sector, focusing on the opportunities it presents, the challenges it entails, and the future outlook for its integration. By examining key developments, policies, and trends, we seek to inform policymakers, industry stakeholders, and researchers about the implications of AI for transportation and mobility within the European context. This paper does not intent to list the complete set of possible actions and activities in this domain and should therefore be considered as first perspectives for deeper discussions.

1.3. Scope

The scope of this paper encompasses various aspects of AI application within the mobility sector, including but not limited to:

- Traffic management systems
- Automotive technologies
- Public transportation networks
- Logistics and supply chain management

When we refer to AI in this context, it is essential to distinguish it from related concepts such as machine learning and big data analysis. According to the EU Artificial Intelligence Act, AI is defined as software that can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with.

This definition excludes simpler forms of data processing or basic automation. Thus, the AI applications discussed in this White Paper will focus on those systems that demonstrate a degree of autonomy and intelligence beyond basic data analysis or rule-based systems. This distinction is critical for understanding the unique opportunities and challenges AI presents within the mobility sector and where additional activities at EU level can foster a strong uptake and use for the benefit of all stakeholders involved.

The AI Act classifies AI systems based on the level of risk they pose low, medium, high, and unacceptable. Low-risk systems typically involve applications such as chatbots or virtual assistants, which may require transparency but do not significantly impact human rights or safety. Medium-risk systems, while requiring more stringent monitoring and oversight, can include tools used in areas like education or employment, where they influence significant decisions but with manageable risks. High-risk AI systems, such as those used in traffic management control centres, healthcare, or other critical infrastructure, are subject to strict regulation due to their potential to cause harm if not properly controlled. Lastly, unacceptable-risk AI systems, including those involving subliminal manipulation or mass surveillance, are outright prohibited under the Act due to the inherent threat they pose to fundamental rights. This risk-based framework is essential for understanding how AI is regulated and managed, particularly in sectors like mobility, where safety, ethics, and human rights must be balanced with innovation and efficiency.

2. Opportunities & Applications of AI in the Mobility Sector

2.1. Enhancing Traffic Management

AI technologies offer unprecedented opportunities to revolutionise traffic management systems, enabling real-time analysis of traffic patterns, predictive modelling of congestion, and dynamic optimisation of traffic flow. AI algorithms can analyse vast amounts of data from sensors, cameras, and connected vehicles to make intelligent decisions, such as adjusting traffic signal timings, rerouting vehicles, and managing lane usage. By reducing congestion, improving road safety, and minimising environmental impact, AI-powered traffic management systems contribute to more efficient and sustainable transportation networks. Research institutions and universities are at the forefront of these advancements, conducting studies and developing innovative algorithms that drive these intelligent traffic management solutions. They explore AI methodologies, evaluate their impact, and publish findings that guide the industry's best practices. Inspiration for these advancements can be found in ERTICO’s activities, as detailed in the annex of this paper.

AI can help to optimise traffic flow and reduce congestion using real-time data from traffic sensors, GPS devices, and connected vehicles. AI-driven systems enable dynamic adjustments to traffic signals, adaptive routing, and prioritisation of public transport and emergency vehicles, enhancing overall traffic efficiency.

Cooperative traffic management, such as C-ITS enabled public transport networks and private vehicle fleets, powered by AI fosters collaboration among municipalities, transport authorities, and private stakeholders, ensuring a holistic and data-driven approach and a fast and efficient adaptation of traffic flows to changing conditions. This AI-enhanced strategy not only improves road safety and efficiency but also contributes to environmental sustainability by reducing emissions and promoting the use of public and alternative transportation modes.

Public authorities play a crucial role in implementing and overseeing these AI-driven traffic management services, ensuring that regulations and policies are in place to support technological advancements while safeguarding public interests. The introduction of the AI Act provides increased regulatory oversight mechanisms, which are essential for maintaining transparency, accountability, and ethical standards in the deployment of AI technologies. Public authorities also facilitate the deployment of necessary infrastructure and provide funding for pilot projects and large-scale implementations, thereby fostering an environment conducive to innovation and sustainable growth and contributing to an immediate AI implementation with possibilities for learning and extending experiences.

2.2. Advancements in Automotive Technologies

The automotive industry is undergoing a profound transformation driven by AI innovations. From automated driving capabilities to predictive maintenance systems, AI-powered technologies are reshaping the way vehicles are designed, developed, operated, and maintained. AI enables the development of higher levels of automation (SAE levels of automation[i]) with vehicles capable of navigating complex environments with minimal human intervention, promising to revolutionise personal mobility, public transportation, and logistics. Vehicle manufacturers and suppliers are at the forefront of incorporating these AI-driven advancements into vehicles, pushing the boundaries of innovation and safety in the automotive sector. OEMs are investing heavily in R&D to integrate AI into their products, ensuring that new vehicles meet the highest standards of safety, efficiency, and user experience.

In addition, V2X (Vehicle-to-Everything) communication technologies play a key role in the future of connected vehicles by enabling real-time data exchange between vehicles, infrastructure, and other road users, enhancing safety and traffic management.The Enhancing Automated Valet Parking (EAVP) [1] platform exemplifies this progress by leveraging AIoT systems, that are based on standardised and open data formats for all stakeholders, primarily camera-based, to enhance both operational efficiency and the customer experience.

Through collaboration between public authorities in cities and regions and private stakeholders and companies, urban mobility can become as flexible and adaptive as travellers need, while remaining manageable and cost-efficient during peak traffic times, based on shared AI-driven interaction rules for digital content. These advanced systems streamline parking operations, reducing congestion and wait times while providing value-added services for customers, such as seamless payment and real-time availability updates. The EAVP initiative demonstrates how intelligent technologies can transform urban mobility, making parking more efficient and user-friendly. OEMs collaborating on such initiatives showcase their commitment to leveraging AI for practical, real-world applications that enhance urban mobility and customer satisfaction.

2.3. Improving Public Transportation Systems

Besides using AI supported level 4 vehicles for public transport, AI holds immense potential to optimise public transportation systems, in the planning, setup and operational phase, making them more reliable, accessible, and user centric. Intelligent routing algorithms can optimise bus schedules, reduce waiting times, and enhance the overall passenger experience. Additionally, AI-powered predictive maintenance systems enable proactive maintenance of buses, trains, and other transit vehicles, minimising downtime and ensuring operational reliability.

Furthermore, AI-based demand forecasting models help transit agencies anticipate ridership patterns and adjust service levels, enhancing the efficiency and sustainability of public transportation networks. Service providers can leverage these AI technologies to offer more responsive and efficient services, improving overall passenger satisfaction. By adopting AI solutions, they can enhance operational efficiency, reduce costs, and deliver better customer information, reliability of service and experiences.

The ERTICO incepted platform on Mobility as a Service (MaaS)[2] integrates various transportation services into a single, cohesive platform, offering users seamless access to a wide range of mobility options through a unified application. AI enhances MaaS by enabling advanced data analytics, predictive modelling, and personalised service delivery. AI-driven algorithms can tailor travel recommendations based on user preferences and real-time conditions, improving the overall user experience.

Additionally, AI facilitates dynamic pricing models, ensuring cost-efficiency and resource optimisation for both service providers and users. In improving public transportation ecosystems, AI has the potential to optimise charging systems for public transport. Dynamic payment systems, which take into account when a person enters and leaves a vehicle, how they combine different transport modes, and travel times, could revolutionise the payment system and significantly reduce costs compared to current solutions.

By integrating AI, MaaS can also enhance sustainability efforts through the promotion of shared and electric mobility options, reducing the environmental impact of transportation. The potential for AI to support operational efficiency in MaaS promises a more intelligent, responsive, and user-centric mobility ecosystem. This synergy between AI and MaaS not only drives innovation but also fosters more efficient, sustainable, and accessible urban mobility solutions. Users benefit from the enhanced reliability, efficiency, and convenience brought by AI in public transportation, leading to higher satisfaction and increased usage of public transport options.

Moreover, Level 4 Automated Vehicle Systems for public transport, a prominent use case in the CCAM initiative, exemplifies how AI can revolutionise public transportation. These systems leverage AI to enable highly automated driving capabilities, reducing the need for human intervention and enhancing safety, efficiency, and accessibility in public transport networks.

2.4. Optimising Logistics and Supply Chain Management

In the realm of logistics and supply chain management, AI technologies offer transformative opportunities to streamline operations, reduce costs, and enhance customer satisfaction. AI-powered predictive analytics enable real-time tracking and monitoring of shipments, allowing logistics companies to proactively address potential delays or disruptions. In particular, collaborative last-mile delivery solutions, where public and private stakeholders work together, are crucial for enhancing efficiency. These collaborations are supported by AI-driven exchange mechanisms that facilitate agreement and coordination among all parties involved, ensuring smoother operations and optimised delivery services. Automated vehicles and drones equipped with AI capabilities facilitate last-mile deliveries, improving efficiency and reducing carbon emissions.

Moreover, AI-driven inventory management systems optimise warehouse operations by predicting demand, minimising stockouts, and reducing inventory holding costs. In this context, the development of the ISO Standard 23795 on Logistics and Supply Chain Management (LCMM) is particularly noteworthy. This standard[3], in which ERTICO played a significant role, requires extensive data collection and processing, potentially through AI systems.

2.5. Applications of AI in Mobility

Numerous case studies showcase the integration of AI technologies in various aspects of the mobility sector, demonstrating their transformative impact on efficiency, safety, and sustainability. For example, some cities have implemented AI-powered traffic management systems that dynamically adjust traffic signals and manage congestion, leading to significant reductions in travel times and emissions.

Similarly, companies like Waymo and Tesla have – to various degrees – developed automated driving systems that leverage AI algorithms to navigate complex environments, demonstrating the potential for safer and more efficient transportation.

2.6. Generative AI, Large Language Models and Automated Speech Recognition

The integration of Generative AI, Large Language Models (LLM), and Automated Speech Recognition (ASR) technologies in the mobility sector is unlocking a range of innovative opportunities. Generative AI and LLMs enable the creation of highly responsive and personalised interactions between users and mobility services, such as virtual assistants that can provide real-time travel advice, itinerary planning, and customer support in multiple languages. These technologies can analyse vast amounts of data, predict user preferences, and generate tailored recommendations, enhancing user experience and operational efficiency.

Automated Speech Recognition further enhances accessibility and safety by enabling voice-activated controls and hands-free communication within vehicles. This not only improves the ease of use for drivers and passengers but also supports safer driving practices by reducing the need for manual inputs. Together, these AI-driven advancements are set to revolutionise how we interact with mobility services, offering more intuitive, responsive, and user-centric solutions.

2.7. AI-Driven Compliance Strategies for EU Policy Targets

AI can play a crucial role in enhancing compliance and accelerating the achievement of the EU Road Safety Policy Framework 2021-2030's ambitious targets. By using predictive analytics, AI can identify high-risk areas and guide more effective, targeted interventions. Technologies such as ADAS (e.g., automated braking, lane-keeping) can reduce human error, while AI traffic management systems are key to optimising traffic flow and minimising congestion.

However, challenges remain, including the need for system interoperability, addressing data privacy concerns, and mitigating algorithmic biases. EU initiatives such as Horizon Europe and the European Partnership on AI, Data and Robotics can drive collaboration and the widespread adoption of AI systems, particularly by leveraging standardised and open data sets already available in Europe. This approach aligns with the EU's road safety objectives, advancing towards safer roads with fewer fatalities and serious injuries. Similarly, AI is pivotal in achieving the EU's zero pollution and carbon-neutral target for 2050.

AI can be harnessed to optimise industrial processes, significantly reducing emissions, while also providing real-time monitoring of air and water quality, enabling timely interventions. AI-powered solutions in transport, such as intelligent traffic management and route optimisation, offer tangible reductions in vehicular emissions and improved fuel efficiency. Yet, complexities related to data accuracy, privacy concerns, and the intricate nature of AI systems must be addressed. Programmes like the European Green Deal and Horizon Europe are essential in fostering the development and deployment of AI, while promoting collaboration and setting the stage for standardisation across sectors.

The Digital Transformation and Data Policy encourages the adoption of digital technologies to enhance public services and drive mobility innovation. The AI Regulation is also pivotal, laying out safety and transparency requirements for AI systems, thereby fostering trust and uptake. Furthermore, the Sustainable and Smart Mobility Strategy seeks to build a more resilient and eco-friendly transport system, incorporating efforts to reduce greenhouse gas emissions while integrating cutting-edge mobility services. The Urban Mobility Framework supports these goals, promoting the use of public transport, active mobility, and clean vehicles. Finally, Horizon Europe remains a key driver of research[4] and innovation in smart, sustainable mobility, with funding channels dedicated to advancing new technologies.

2.8. Lessons Learned from Implemented Projects

While many AI projects in the mobility sector have achieved success, others have faced challenges and setbacks, highlighting the importance of careful planning, collaboration, and risk management. Lessons learned from implemented projects emphasise the need for robust data infrastructure, quality assurance processes, standardisation, and stakeholder engagement to ensure the reliability and effectiveness of AI systems.

Additionally, ethical considerations, such as bias mitigation and transparency, are critical to building trust and acceptance among users and communities. Moreover, ongoing monitoring, evaluation, and adaptation are essential to address emerging issues and optimise the performance of AI-driven solutions over time. One lesson learned in connected and automated mobility in Europe is the necessity to collaborate even more between public authorities and private organisations to build common experiences and trust.

By studying both successful and unsuccessful case studies, stakeholders can gain valuable insights into the opportunities and challenges associated with AI implementation in the mobility sector. By applying best practices and lessons learned, they can maximise the benefits of AI technologies while mitigating risks and ensuring responsible and sustainable deployment. Ultimately, the exchange of knowledge and experiences will contribute to the continued advancement and innovation of AI in mobility, driving towards a more efficient, inclusive, and resilient transportation system for all.

[4] https://joint-research-centre.ec.europa.eu/index_en

3. Challenges Associated with AI Implementation

3.1. Compliance with existing rules and regulations in the Traffic Management sector

AI systems must navigate a complex landscape of local, national, and international traffic laws, which are often inconsistent and subject to frequent updates. Ensuring that AI solutions adhere to these regulations requires continuous monitoring and adaptation, posing technical and operational difficulties. Additionally, the integration of AI with legacy traffic management systems present compatibility and interoperability issues, necessitating substantial modifications to existing infrastructure.

Furthermore, regulatory frameworks themselves may lag technological advancements, creating a grey area where AI applications might operate without clear legal guidance. Addressing these challenges necessitates close collaboration between AI developers, regulatory bodies, and transport authorities to establish robust, adaptive frameworks that ensure both innovation and compliance. However, significant issues arise in qualifying Traffic Management centres as high risk under current frameworks.

The TM 2.0 position paper[5] provides a snapshot of these challenges, advocating for a nuanced approach to regulation in this critical area. The TM2.0 Platform Position Paper addresses the inclusion of road traffic management as a high-risk AI system in the AI Act's Annex III. It stresses the need for a nuanced, risk-based approach to AI regulation in traffic management, where the criticality of AI applications should be assessed within the 'traffic management data decision chain.' TM2.0 advocates for developing sector-specific guidelines in collaboration with all relevant stakeholders, ensuring that innovation, particularly those enhancing road safety, is not hindered by overly broad classifications. The paper calls for distinguishing between strategic, tactical, and operational decision-making in AI traffic management, ensuring that only AI systems with significant potential harm are classified as high-risk, thus avoiding unnecessary regulatory burdens that could stifle advancements in the sector.

Particularly in transport and mobility, AI applications strongly correlate with digitalisation, providing further impetus for digitising the sector and building public digital infrastructure alongside physical infrastructure. This effort is crucial for equipping public institutions for the future and facilitating public competence building to create a trustworthy environment for AI, which will be essential for its social acceptance and the take-up of applications. These AI applications depend on comprehensive data available in standardised and open formats, highlighting the need for a robust digital foundation to support their successful implementation.

3.2. Job skills

The introduction of advanced AI systems requires a workforce equipped with specialised skills in AI development, data analytics, and system integration. However, there is often a skills gap, with current employees lacking the necessary training to manage and operate AI technologies effectively. Upskilling existing staff and attracting new talent with the requisite expertise involves considerable time and financial investment.

Moreover, the rapid evolution of AI technologies means that continuous learning and adaptation are essential, placing ongoing demands on educational and training institutions. Additionally, there is a potential for job displacement, as AI systems may automate tasks traditionally performed by human workers, leading to resistance from the workforce and necessitating thoughtful transition strategies. However, these concerns could be somewhat mitigated through proper communication of AI systems' capabilities. While AI may take over routine, repetitive tasks, employees' skills could be transitioned to new roles that leverage human expertise, particularly in areas that require critical thinking, creativity, or human oversight.

Furthermore, reskilling is critical, particularly in safety-critical operations, where over-reliance on AI systems might leave employees unprepared to manage tasks manually in the event of a system malfunction or outage. Lack of practice in executing these tasks without AI support could lead to reduced confidence and ability in responding effectively, especially in high-stakes scenarios. Addressing these challenges requires an effort from industry stakeholders, educational institutions, and policymakers to develop comprehensive training programmes, career development pathways, and support systems to ensure a smooth and equitable integration of AI into the mobility sector.

3.3. Safety and Security Concerns

One of the greatest challenges in implementing AI in the mobility sector revolves around ensuring the safety and security of AI-powered systems. As AI technologies become increasingly integrated into transportation infrastructure and vehicles, concerns arise regarding their reliability, robustness, and vulnerability to cyberattacks. Ensuring the safety of AI-driven automated vehicles, requires rigorous testing, validation, and certification processes to mitigate the risk of accidents and ensure public trust in the technology.

Additionally, safeguarding AI systems against cybersecurity threats is paramount to prevent malicious actors from exploiting vulnerabilities and compromising the integrity of critical transportation systems.

Another challenge is attributing (product-) liability in the event of accidents or system failures involving AI-powered solutions. This issue is being addressed, in part, by the new Product Liability Directive and the proposed AI Liability Directive, which aim to clarify liability frameworks in the context of AI systems. It is recommended to develop comprehensive certification programs and promote them to all stakeholders to create trust in developed and deployed AI-based solutions. AI is not a threat, but its existence is undeniable, and we must be prepared to cope with its growing presence in the mobility sector.

3.4. Ethical Considerations

Ethical considerations represent another significant challenge in the deployment of AI within the mobility sector. AI algorithms, trained on vast amounts of data, have the potential to perpetuate biases and discriminatory outcomes, particularly in applications such as predictive policing and automated decision-making. A human-centric approach to AI development and implementation is crucial to ensure that these systems are designed with the well-being of individuals in mind. Key ethical concerns include integrating ethical principles at every phase of AI development, finding the balance between human control and autonomy in safety-critical situations, and assessing the long-term societal impact of AI, such as on urban environments and accessibility.

Moreover, ethical norms may vary globally, necessitating alignment across regions. Ensuring diversity in training datasets, securing informed consent, managing data sovereignty, and addressing the environmental trade-offs of AI efficiency also require attention. Mechanisms for tracing and handling failures and fostering public trust through transparent communication are equally vital. Addressing ethical concerns requires transparent and accountable AI governance frameworks that prioritise fairness, accountability, and transparency.

Ensuring that AI systems operate in accordance with legal and ethical principles, such as privacy rights and non-discrimination, is essential to foster public acceptance and mitigate societal risks associated with AI deployment. AI must be restricted by experts and by existing and future regulations. AI might pose some challenges that need to be addressed, but certainly offers many and various opportunities. With proper preparation, planning and involvement of relevant stakeholders, these systems could be incorporated into everyday life in a safe, secure and trusted way.

3.5. Regulations & Standards

Navigating the complex regulatory landscape surrounding AI poses a considerable challenge for stakeholders in the mobility sector. As policymakers grapple with the implications of AI for safety, privacy, and liability, regulatory frameworks must strike a balance between promoting innovation and protecting public interests. Harmonising AI regulations across different jurisdictions presents a further challenge, as divergent legal frameworks may impede cross-border deployment and interoperability of AI-powered systems. Moreover, the dynamic nature of AI technologies necessitates agile regulatory approaches that can adapt to rapid technological advancements while safeguarding against potential risks and abuses.

The ISO TC204 Working Group 2.0, focusing on "Big data and artificial intelligence supporting intelligent transport systems," plays a crucial role in this transformation. They have been drafting Technical Report TR12786, which collects various Use Cases showcasing AI applications in mobility. Contributions to this report come from several ERTICO led projects such as 5G-LOGINNOV, 5G META and from organisations such as Car2Car-Communication Consortium, C-Roads, and ETSI. These initiatives highlight the collaborative efforts within the industry to harness AI for smarter and more connected transport solutions and have contributed to a common set of specifications which forms a strong basis for the implementation.

3.6. Data Privacy and Ownership

The proliferation of AI in the mobility sector raises significant concerns regarding data privacy and ownership rights. AI algorithms rely on vast amounts of data, including personal information, traffic patterns, and environmental data, to make informed decisions and predictions. However, the collection, processing, and sharing of sensitive data raise privacy concerns and ethical dilemmas regarding consent, transparency, and data sovereignty. The implementation of the Data Act also plays a crucial role in addressing these issues by establishing clear guidelines for data sharing and usage. In simpler terms, it is vital to establish clear rules and involve all relevant parties in creating equitable data management practices.

Addressing the challenges associated with AI implementation in the mobility sector requires a multidisciplinary approach that engages stakeholders from government, industry, academia, NGO, and civil society. By proactively addressing safety, ethical, regulatory, and privacy concerns, stakeholders can harness the transformative potential of AI to create more efficient, equitable, and sustainable transportation systems.

3.7. Environmental Concerns Regarding Energy Consumption

One of the significant challenges associated with the use of AI in mobility and transport is the environmental impact related to the required energy. AI algorithms, particularly those used in large-scale data processing, require substantial computational power, leading to increased energy demand. This energy-intensive process can contribute to higher carbon emissions, if the energy sources are not renewable. By prioritising the development of energy-efficient AI technologies and promoting the use of renewable energy sources, we can significantly enhance the positive impact of AI in mobility. Emphasising sustainability will not only mitigate environmental concerns but also ensure that the transformative benefits of AI can be realised without compromising our ecological goals. Addressing these concerns requires a focus on developing energy-efficient AI technologies and promoting the use of renewable energy sources in AI operations to ensure that the environmental advantages of AI in mobility are not undermined by its energy footprint.

3.8. Data Quality

Data quality is a critical challenge in the implementation of AI in the mobility sector, as the efficacy of AI systems is heavily dependent on the quality of data they are trained on and operate with. Poor data quality can significantly compromise the performance of AI applications, leading to inaccurate predictions, flawed decision-making, and ultimately, suboptimal traffic management outcomes. Issues such as incomplete data, data inaccuracies, inconsistencies, and biases can spread through AI models, resulting in incorrect outputs that undermine the reliability and effectiveness of these systems. Within this context, the availability of large datasets (e.g., daily, weekly, or regularly collected) for testing and training purposes of advanced AI models is crucial. Such data enables rapid learning from existing evidence and extends knowledge into new domains, fully supporting AI-driven developments and tooling. This not only enhances the models that researchers utilise but also brings additional benefits to the operators of road and transport networks as a whole.

When talking about the use of AI in the context of Traffic Management, it is important to distinguish between two types of data: the data used for training the AI (the “training set”) and the data the trained AI application is then applied to. For the training set, quality is very important. If the traffic data used for training the AI is not consistently updated or contains errors, AI-driven traffic management solutions might fail to optimise traffic flow, causing congestion or increasing the risk of accidents. If the input data to train the AI is flawed, the trained AI's outputs will also be flawed. Ensuring high-quality input data involves rigorous data collection, validation, and cleansing processes, as well as establishing robust data governance frameworks.

This necessitates significant investment in data infrastructure and continuous collaboration among data providers, AI developers, and traffic management authorities to maintain the integrity and accuracy of the data used in AI systems. However, in terms of the application of AI in traffic management, it could be that the AI is actually used to mitigate the bad quality input data, if the AI is trained to do so. The AI can be trained to expect lower quality input. If the AI is trained to expect only high-quality input data, then of course the quality needs to be high for it to work.[6] Data mandated by regulations must provide the required quality, and this quality needs to be controlled and ensured.

4. EU State of Play: Policies and Initiatives

4.1. Overview of EU Regulatory Framework on AI

The EU has been proactive in developing regulatory frameworks to govern the ethical and responsible use of AI technologies. In March 2024, the European Parliament adopted the AI Act, which aims to regulate AI systems based on their risk levels. The Act introduces requirements for transparency, accountability, and human oversight, with stricter rules for high-risk AI applications, such as automated vehicles and critical infrastructure.

Apart from the AI Act, it is important to note that sector-specific regulations remain highly relevant, particularly in areas like mobility[7]. This regulatory framework represents a significant step forward in ensuring that AI technologies are developed and used in a manner that is safe, ethical, and respects fundamental rights. It supports innovation while safeguarding public trust and aims to position Europe as a global leader in AI regulation.

4.2. Role of the European Commission in AI Governance

The European Commission plays a central role in coordinating AI governance efforts across member states. Through initiatives such as the European AI Strategy[8] and the European AI Alliance[9], the Commission fosters collaboration between public and private industrial stakeholders to promote AI innovation while ensuring compliance with ethical and legal standards.

4.3. Key Initiatives Supporting AI Development

In addition to regulatory measures, the EU has launched various initiatives to support AI development and adoption. The Digital Europe Programme allocates funding for AI research, innovation, and skills development, aiming to strengthen Europe's competitiveness in AI technologies.

Moreover, the European AI Fund invests in AI startups and scaleups, fostering the growth of the European AI ecosystem. Furthermore, the European AI Data Spaces initiative aims to create data-sharing infrastructures to facilitate AI-driven innovation across different sectors, including transportation and mobility with open data formats.

The EU's commitment to promoting responsible AI innovation is reflected in its comprehensive regulatory framework and supportive initiatives. By establishing clear rules and incentives for AI development and adoption, the EU aims to foster trust, transparency, and accountability in AI technologies, ensuring their safe and ethical use in the mobility sector and beyond.

5. Perspectives for Policymakers

5.1. Policy Framework Enhancements

Policymakers should prioritise the development of comprehensive and adaptive regulatory frameworks that address the unique challenges posed by AI in the mobility sector. This includes establishing clear guidelines for the design, deployment, and operation of AI-powered systems, with a focus on safety, ethics, and accountability [10]. Additionally, policymakers should foster collaboration between government agencies, industry stakeholders, and research institutions to ensure that regulations keep pace with technological advancements and promote innovation while safeguarding public interests. ERTICO and its various innovation platforms are fully prepared and eager to actively contribute to the development of these guidelines. This effort must take place on multiple levels—international, national, regional, and local - to ensure a holistic approach that accommodates the diverse needs and conditions of different jurisdictions. In this context, it is crucial to include a dedicated section on cities, as local policymakers will play an increasingly vital role in shaping the future of mobility. Enhanced safety, efficiency, and sustainability in the sector cannot be achieved without their active participation and leadership.

5.2. Support for Research and Innovation

Investments in research and innovation are crucial to unlocking the full potential of AI in mobility and driving sustainable economic growth. Policymakers should allocate funding and resources to support interdisciplinary research initiatives that address key technical challenges, such as AI safety, interpretability, legal aspects, and fairness. Furthermore, it is vital to promote large-scale research and deployment efforts to ensure the effective integration of AI solutions across the mobility sector. Policymakers should incentivise industry-academic partnerships and knowledge sharing to accelerate technology transfer and commercialisation of AI-driven solutions, fostering a vibrant ecosystem of innovation and entrepreneurship.

In the European context, cooperation among member states is essential to scale applications and build competencies, enhancing sovereignty and resilience. Policymakers should prioritise the development of central competencies within the EU and establish a supportive business and governance ecosystem that facilitates impactful innovation. By doing so, Europe can ensure it remains competitive in the global AI landscape while creating significant societal and economic value.

5.3. International Collaboration

Given the global nature of AI and mobility challenges, policymakers should prioritise international collaboration and knowledge exchange to develop harmonised standards, best practices, and regulatory frameworks. Moreover, policymakers should leverage existing multilateral platforms, such as the EU-US AI Regulatory Cooperation Forum, to facilitate cross-border cooperation and alignment of regulatory approaches, promoting interoperability and backwards compatibility as well as market access for AI-enabled mobility solutions. By implementing these recommendations, policymakers can create an enabling environment that fosters responsible AI innovation, promotes competitiveness, and enhances societal well-being in the mobility sector. By balancing regulatory certainty with flexibility, policymakers can unlock the transformative potential of AI to create safer, more efficient, and sustainable transportation systems for the benefit of all.

6. Future Outlook and Trends

6.1. Predictions for AI Adoption in Mobility

The future of AI in the mobility sector is poised for significant growth and innovation. Rapid advancements in AI technologies, coupled with increasing demand for smarter and more efficient transportation solutions, are driving widespread adoption across various domains. From automated and vehicles and smart cooperative traffic management systems to AI-powered logistics and supply chain optimisation, the potential applications of AI in mobility are vast and diverse. As AI continues to mature and become more accessible, we can expect to see accelerated deployment and integration across the mobility ecosystem, revolutionising how people and goods move from one place to another.

6.2. Emerging Technologies and Innovations

Several emerging technologies and trends are shaping the future of AI in mobility. AI and deep learning algorithms are becoming increasingly sophisticated, enabling more accurate predictions, real-time decision-making, and adaptive behaviour in AI systems. Edge computing, fibre cable and wireless connectivity are facilitating the deployment of AI-powered applications at the edge of networks, enabling faster response times and reduced latency for mission-critical tasks such as automated driving and real-time traffic management.

6.3. Implications for Stakeholders

The widespread adoption of AI in mobility will have far-reaching implications for various stakeholders, including governments, industry players, and consumers. For policymakers, AI presents opportunities to improve the efficiency, safety, and sustainability of transportation systems, while also posing challenges related to regulation, ethics, and privacy.

For industry players, AI opens new avenues for innovation, business model disruption, and competitive differentiation, while also necessitating investments in talent, infrastructure, and cybersecurity. For consumers, AI promises enhanced convenience, safety, and personalised experiences, while also raising concerns about data privacy, security, legal framework, and ethical implications.

As AI continues to reshape the mobility landscape, stakeholders must collaborate to address the challenges and opportunities presented by this transformative technology. By fostering innovation, fostering collaboration, and ensuring responsible AI deployment, we can harness the full potential of AI to create more efficient, equitable, and sustainable transportation systems for the future.

6.4. Implications for vulnerable road users

The integration of AI in mobility systems holds significant implications for vulnerable road users, such as pedestrians, cyclists, and individuals with disabilities. Advanced AI technologies can enhance safety through real-time monitoring and predictive analytics, enabling proactive measures to prevent accidents. These systems can facilitate the development of more inclusive transport infrastructure, such as smart crosswalks and adaptive traffic signals, thereby improving accessibility and mobility for all.

However, challenges persist in ensuring the equitable distribution of these benefits, addressing privacy concerns, and maintaining the reliability of AI systems in diverse urban environments. Ensuring robust stakeholder engagement and inclusive policymaking will be crucial in harnessing AI's potential to protect and empower vulnerable road users.

6.5. Risks and Challenges

However, it is crucial to recognise that the deployment of AI in mobility also presents risks. Severe failures or malfunctions could erode public trust, making it essential to address these issues proactively.

Additionally, there is a growing apprehension among the public about AI, stemming from a lack of understanding and insufficient trust-building measures. This can result in resistance to AI technologies and hinder their acceptance and integration.

6.6. Acceptance and Inclusion

Addressing these concerns requires a focus on acceptance and inclusion. Developing comprehensive certification programs and promoting them to all stakeholders can help build trust in AI-based solutions.

Furthermore, ensuring that public institutions are equipped for the future and facilitating public competence building are essential steps in creating a trustworthy environment for AI. Proper communication with the public is vital; explaining how these systems work and detailing how risks are acknowledged and mitigated can significantly enhance the acceptance of AI technologies. It is also crucial to develop comprehensive data infrastructures that support the effective deployment of AI applications, which depend on standardized and open data formats.

By prioritising these aspects, stakeholders can foster a more inclusive and informed approach to AI adoption in the mobility sector, ultimately driving greater social acceptance and effective utilisation of AI technologies.

[1] https://www.sae.org/standards/content/j3016_202104/
[1] www.eavp.eu
[1] https://maas-alliance.eu/
[1] https://erticonetwork.com/erticos-members-contribute-to-worldwide-iso-standardisation/
[1] https://tm20.org/position-paper-on-the-artificial-intelligence-ai-act/
[1] https://datex2.eu/
[1] https://artificialintelligenceact.eu/annex/1/
[1] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[1] https://digital-strategy.ec.europa.eu/en/policies/european-ai-alliance
[1] https://www.gartner.com/en/research/magic-quadrant

Annex: ERTICO activities, platforms and other initiatives of relevance for AI

1. TM2.0 (Traffic Management 2.0)

Description: TM2.0 aims to advance interactive traffic management systems through collaborative efforts under the ERTICO umbrella, integrating and enhancing these systems with innovative approaches.

AI Integration:

- Leveraging AI for real-time traffic data analysis.
- Utilising predictive modelling to optimise traffic flow.
- Improving traffic signal and routing efficiency through AI algorithms.

Link: https://tm20.org/

2. TN-ITS (Transport Network ITS)

Description: TN-ITS focuses on the seamless exchange of transport network data between public authorities and map providers. This project enhances the accuracy and timeliness of digital maps used in ITS.

AI Integration:

- Utilisation of AI to process and harmonise transport network data.
- Enhanced map updates and real-time data integration through machine learning algorithms.

Link: https://tn-its.eu/

3. EAVP (Enhancing Automated Valet Parking)

Description: EAVP is an initiative to enhance parking operations using AI and IoT systems, specifically through camera-based technologies.

AI Integration:

- Streamlining parking operations with AI-powered systems.
- Reducing congestion and wait times using real-time data processing.
- Providing value-added services like seamless payment and real-time availability updates through AI.

Link: https://eavp.eu/

4. MaaS Alliance (Mobility as a Service)

Description: MaaS integrates various forms of transport services into a single accessible on-demand service, accessible via a unified digital interface.

AI Integration:

- Advanced data analytics and predictive modelling to optimise route planning and service delivery.
- Personalised travel recommendations using AI-driven algorithms.
- Dynamic pricing models for cost-efficiency.

Link: https://maas-alliance.eu/

5. 5G-LOGINNOV

Description: 5G-LOGINNOV is a EU funded project focused on enhancing logistics operations through the application of 5G technologies and AI. The project aims to address various challenges in logistics and port operations, leveraging cutting-edge technological advancements to improve efficiency and effectiveness.

AI Integration

- Predictive Analytics for Real-Time Tracking and Monitoring: Utilising AI to predict and monitor shipment statuses in real time, ensuring improved logistics efficiency and timely deliveries.
- AI-Driven Inventory Management: Optimising warehouse operations through intelligent inventory management systems, enhancing storage and retrieval processes.
- Automated Vehicles and Drones: Deploying AI-powered automated vehicles and drones to streamline last-mile delivery, reducing operational costs and improving delivery speed.

Link: https://5g-loginnov.eu/

6. WE-TRANSFORM

Description: WE-TRANSFORM is an EU funded project addressing the rapid changes in mobility, driven by new customer demands, technologies, and environmental goals. The project focuses on the impact of automation on transport labour, seeking to ensure sustainable, affordable, and accessible mobility services by understanding and preparing for evolving labour requirements, skills, and competencies.

AI Integration:

- AI in Training: Utilisation of AI-driven digital tools to identify future skills needs and support career paths and learning opportunities.
- Skill Identification: Employing AI to pinpoint essential skills for the future automated and digitalised work environment, categorised by transport mode.
- Enhanced Decision-Making: Leveraging AI for real-time data analytics to facilitate evidence-based policymaking and informed governance.
- Data Quality and Consistency: Ensuring data quality and consistency through machine learning techniques.

Link: https://wetransform-project.eu/

7. EU-EIP (European ITS Platform)

Description: The European ITS Platform aims to support the deployment and operation of cooperative ITS services across Europe.

AI Integration:

- AI-driven cooperative ITS services for traffic management and safety.
- Real-time data processing and analytics for improved decision-making.
- Enhanced communication between vehicles and infrastructure through AI algorithms.

Link: https://www.its-platform.eu/