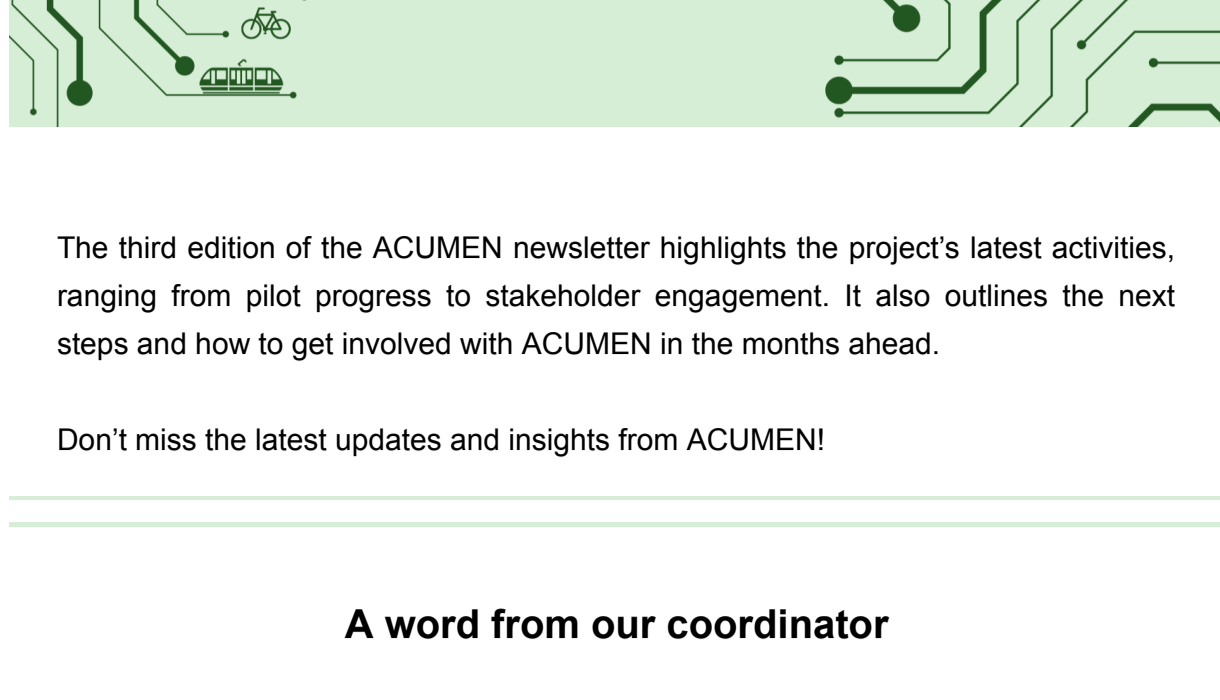
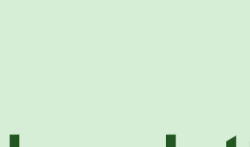


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The third edition of the ACUMEN newsletter highlights the project's latest activities, ranging from pilot progress to stakeholder engagement. It also outlines the next steps and how to get involved with ACUMEN in the months ahead.

Don't miss the latest updates and insights from ACUMEN!

## A word from our coordinator

As ACUMEN moves towards the next stage of implementation, the results of its research and pilot activities are becoming increasingly visible. The recent Reference Group meeting in Luxembourg provided a valuable opportunity to discuss how the artificial intelligence-based tools that we are developing, could support smarter, more transparent and efficient traffic management. Engaging with experts and stakeholders reaffirmed that governance, collaboration and public trust are vital for successful deployment.

Meanwhile, ACUMEN partners presented their scientific results at the [9th International IEEE Conference on Intelligent Transportation Systems](#), showcasing progress in areas such as privacy-preserving control, dynamic incentives, and multimodal resilience. Across the pilot sites in Athens, Amsterdam, Helsinki and Luxembourg, technological integration and testing are advancing rapidly, turning research into practical applications.

The lessons learned from these activities will inform the forthcoming City Guidebook for AI System Integration and future policy recommendations.

**Claudio Roncoli**

Coordinator - ACUMEN

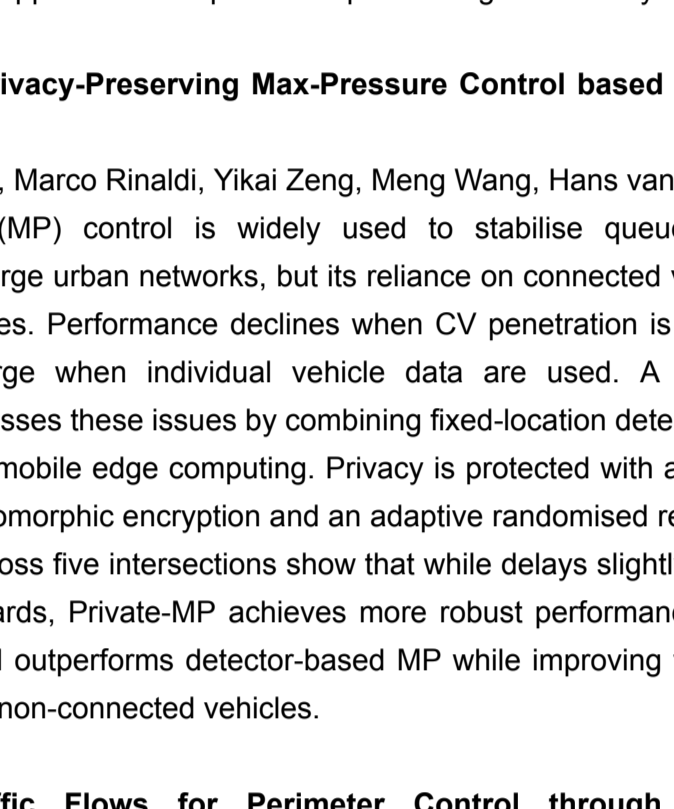
## Reference Group Meeting

On 10 September 2025, the ACUMEN Reference Group met in Luxembourg to discuss the integration of artificial intelligence (AI) into traffic management. The meeting was adjacent with the 9th International IEEE Conference on Models and Technologies for Intelligent Transportation Systems, at which ACUMEN organised a special session dedicated to door-to-door traffic management.

After the morning conference session, Claudio Roncoli opened the Reference Group meeting with a welcome address. Partners then presented progress from the project's four pilot sites. In Athens, AI is being used to develop and test a mobility platform that integrates transport and logistics into digital twins. In Amsterdam, the focus is on AI for coordinated multimodal management during incidents. In Helsinki, pilots are exploring how incentives could influence travellers to manage traffic more efficiently across modes. In Luxembourg, the work centres on optimising automated mobility services at a local level. Each presentation was followed by a question-and-answer session with Reference Group members.

The second half of the afternoon was dedicated to a workshop, led by LuxMobility, on 'Building smarter decisions for AI in traffic management: insights and feedback from ACUMEN'. The session explored governance, data and regulatory issues, and emphasised the importance of collaboration between governments, operators and citizens. It also addressed concerns such as transparency, ethics, data privacy and equitable access. Participants were introduced to ACUMEN's draft decision-making tool, which is designed to guide cities through three phases: assessing AI readiness; evaluating the suitability of AI solutions for local challenges; and ensuring robust governance and validation. Using Mentimeter, participants provided feedback on the tool's structure and content, helping to refine the questions and priorities for its future use.

The outcomes of the workshop will inform the forthcoming ACUMEN City Guidebook for AI System Integration and the project's policy recommendations. These will support cities and regions in making informed choices about adopting AI in traffic management, ensuring that technological advances are matched with robust governance and public trust.



## ACUMEN special session at MT-ITS 2025

From 8–10 September 2025, the 9th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS 2025) took place at the University of Luxembourg's Kirchberg Campus, co-organised by the MobiLabTransport Research Group and the IEEE ITSS Benelux Chapter.

As part of the programme, a **special ACUMEN session** chaired by our Coordinator Claudio Roncoli included a series of presentations dealing with traffic management, optimisation, and reinforcement learning approaches.

Full papers will appear in IEEE-published proceedings later this year.

### Private-MP: Privacy-Preserving Max-Pressure Control based on Mobile Edge Computing

(Chaopeng Tan, Marco Rinaldi, Yikai Zeng, Meng Wang, Hans van Lint)

Max-pressure (MP) control is widely used to stabilise queues and improve throughput in large urban networks, but its reliance on connected vehicle (CV) data poses challenges. Performance declines when CV penetration is low, and privacy concerns emerge when individual vehicle data are used. A new Private-MP controller addresses these issues by combining fixed-location detector data with CV inputs through mobile edge computing. Privacy is protected with a mechanism that integrates homomorphic encryption and an adaptive randomised response strategy. Simulations across five intersections show that while delays slightly increase due to privacy safeguards, Private-MP achieves more robust performance under low CV penetration and outperforms detector-based MP while improving fairness between connected and non-connected vehicles.

### Metering Traffic Flows for Perimeter Control through Auction-Based Signalling Using Connected Vehicles

(Alexander Roocroft, Marco Rinaldi)

Urban congestion continues to challenge cities, with traditional signal control struggling during peak periods. Perimeter control of Protected Networks offers a way to reduce gridlock, and an auction-based mechanism is proposed to allocate green time at intersections. Using a Sealed Bid, Second Price framework, the approach combines real-time monitoring with market-inspired methods to regulate vehicle inflows, extending flexibility by assigning budgets to individual traffic movements. Tests on a controlled inflow intersection show improved performance compared with a fixed-time approach, reducing queues, delays, and improving inflow regulation. The method is scalable to generic intersections, linking perimeter control with market-based auctions to advance adaptive traffic management.

### Ride-Hailing Vehicle Rebalancing Strategies Under Disruptions: A Case Study in Athens

(Euntak Lee, Rim Slama, Nikolas Geroliminis, Ludovic Cleclercq)

The global ride-hailing industry is a key element of multi-modal transport, especially for first- and last-mile connections. While most research on ride-hailing rebalancing assumes regular demand patterns, it is important to account for disruptions that reduce efficiency. This work tests rebalancing strategies that improve the resilience of multi-modal transport systems, incorporating user preferences and demand uncertainty. A multi-agent reinforcement learning approach, based on the MADDPG algorithm, is applied to address stochastic supply-demand dynamics. Results show improvements in waiting time, resilience, total travel time, and travel distance.

### Inferring Traffic Control Policies with Supervised Learning: A Case Study on Max Pressure

(Robin Abohari, Marco Rinaldi, Hans van Lint, Chaopeng Tan)

Smart traffic systems such as SCOOT, SCATS and TUC optimise traffic flow by adjusting signal timings in real time, but the objective functions guiding these systems are often not publicly available. Greater transparency is needed to support cooperation and improvement across jurisdictions and operators. To address this, computer models were trained to mimic the decisions of traffic light systems using simulated network data from virtual sensors. Supervised models, including decision trees and neural networks, replicated system actions with up to 99% accuracy. This approach shows that supervised learning can uncover the hidden objective functions behind signal control and provide insights into the factors influencing traffic management.

### Dynamic Incentives for Alleviating Congestion and Reducing Emissions in Urban Transport Networks: A Reinforcement Learning Approach

(Germán Pardo-González, Shaghayegh Vosough, Katerina Papadaki, Claudio Roncoli)

Traffic management has often relied on toll-based road pricing, but concerns over accessibility and public acceptance have limited its use in some regions. An alternative approach allocates incentives dynamically to encourage drivers to reroute, with the aim of reducing both travel times and emissions. Using a multi-agent reinforcement learning framework and traffic simulation, incentives are assigned to optimise system performance. Results show a 16% reduction in total travel time with sufficient budget, and a 9% reduction in CO<sub>2</sub> emissions when minimising emissions is prioritised. A trade-off exists between time and emissions, but with balanced objectives, both outcomes can be improved beyond the baseline.

## Progress

### Athens Pilot:

NTUA has completed the development of the short-term traffic forecasting and incident detection models, submitting the deliverables in AUSTI. These new, theory-inspired models use the Flow-Theory Informed (FTI) loss function to predict future traffic conditions, such as Mean Speed and volume, with an error margin of less than 10%, thereby enhancing the trustworthiness of the models. The system can also detect incidents in near real time, enabling faster responses. In parallel, drone footage from key locations on the road network has been analysed to assess the impact of on-street parking and delivery vehicles on traffic flow.

### Amsterdam Pilot:

The Amsterdam pilot uses a **strategic simulation** to explore how joint multimodal management strategies can **help move people to different modalities**, when they experience **disruptions during their travels**. The goal is to create a decision support model that coherently simulates different components of the mobility ecosystem and the impact of these decisions, to enable improved flexibility and resilience when facing network disruptions. At this stage of the ACUMEN program, the traffic network for the simulation has been prepared and fed with data on traffic lights and public transport infrastructure. Traffic zones have been generated to apply the management control strategies on.

Initial test runs of the simulation in the Aimsun have shown that a higher detail of traffic data is needed to more accurately assess the impact of the disruptions and the management strategies. The Amsterdam pilot is in the process of attaining this data from the City of Amsterdam to include in the (re)calibration of the demand data and prepares to validate the new set-up.

### Helsinki Pilot:

The Helsinki pilot has finished collecting data on the use of the PayiQ mobile app to encourage sustainable, low-carbon travel. The GreenImpact feature encourages people to switch from private cars to public transport and city bikes, helping to ease congestion during peak hours.

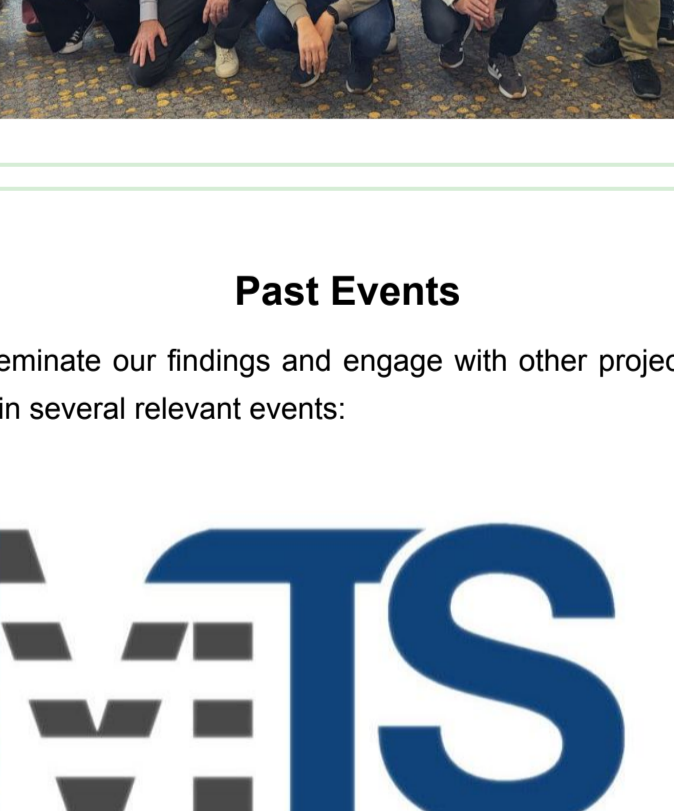
The Digital Twin is now in an advanced integration stage and it integrates also the simulation tool AIMSun. Data from multiple sources, including three drone-swarm campaigns, has been incorporated to support model calibration and analysis. The pilot has also attracted significant media and public attention. The next phase will focus on validating the Digital Twin and testing incentive and data fusion strategies in simulations using drone and app data, to explore ways of further encouraging walking, cycling and using public transport.

### Luxembourg Pilot:

The Luxembourg pilot launched its on-demand mobility app in the Contern activity area in March 2025. Initial users are currently testing the service. The information campaign will soon follow to raise traveller awareness. In June 2025, simulation results for the optimised on-demand service integrated with train schedules were presented at three international conferences (BIVEC/Luxembourg, hEART/Munich and CASPT/Kyoto). Studies on the social readiness of autonomous on-demand services, particularly for users with reduced mobility, were also presented at the BIVEC and MT-ITS conferences in Luxembourg. In Esch, the on-demand app has been customised for the autonomous shuttle, and initial connectivity tests between the user app and the shuttle's on-board system have been successfully completed.

## MTM Cluster

ACUMEN has continued its contribution to the Multimodal Traffic Management (MTM) cluster, an important initiative that not only provides an opportunity for knowledge exchange but also gives it a key position in shaping the European Union's approach to network and traffic management

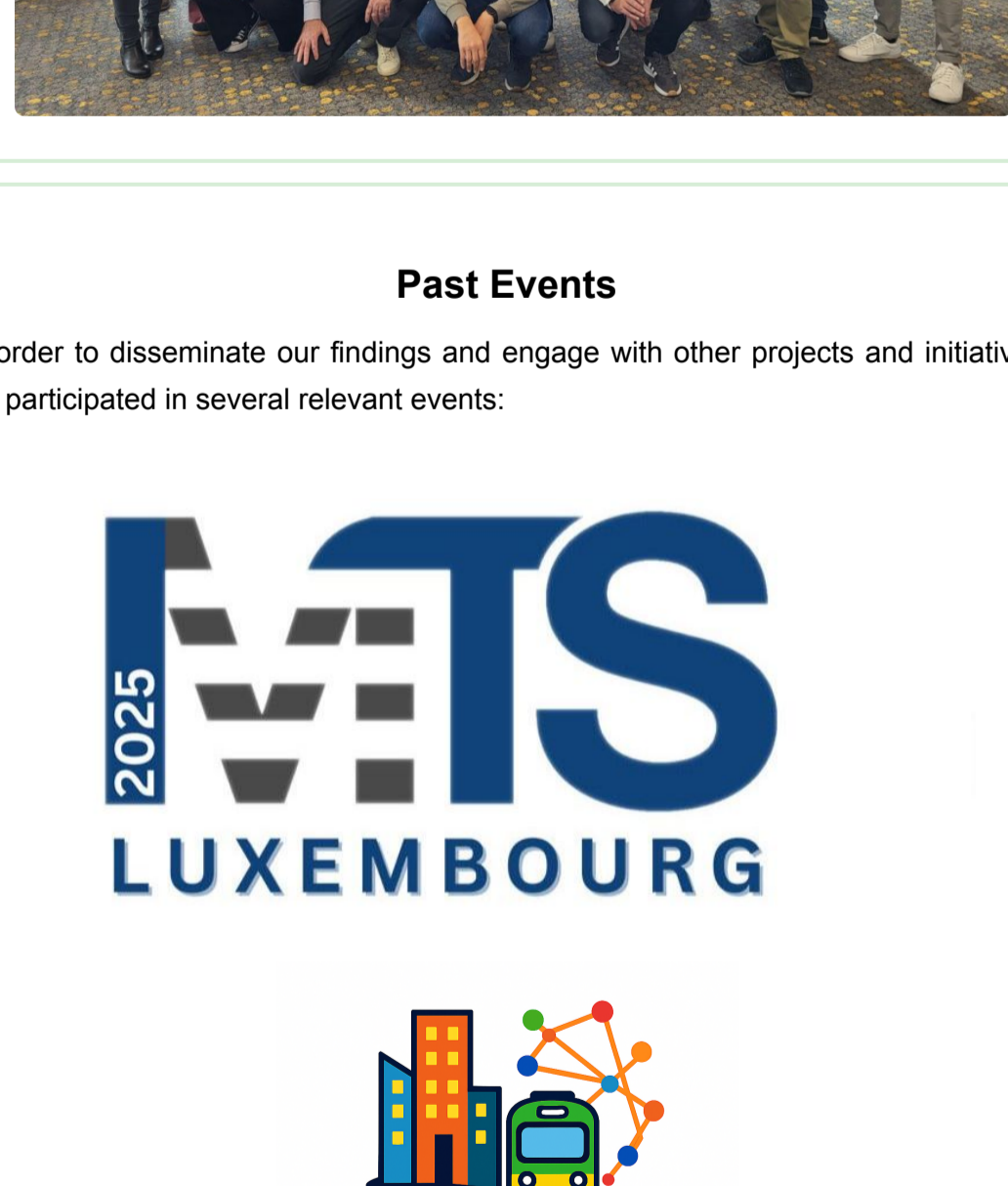


### MTMC in Thessaloniki

On 16 October, the members of the MTMC Cluster will meet in Thessaloniki to discuss the technologies and solutions developed within the various projects, and to welcome the new projects joining the cluster.

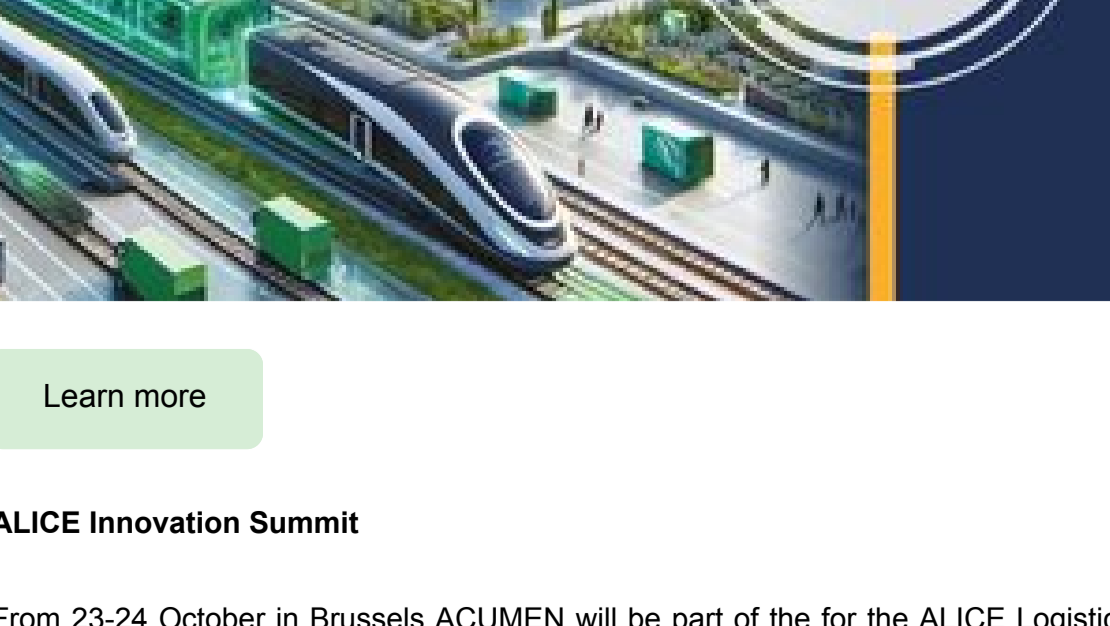
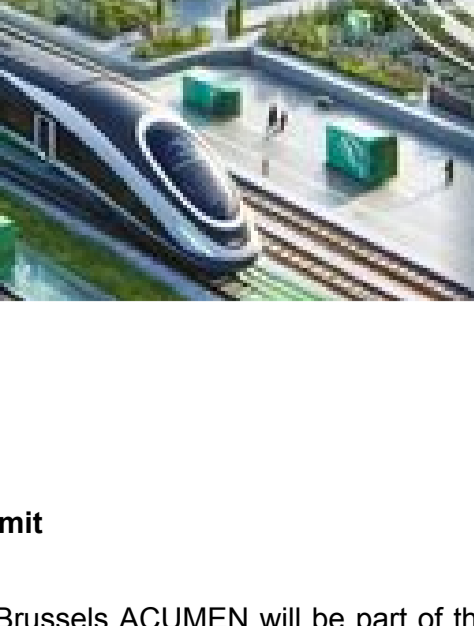
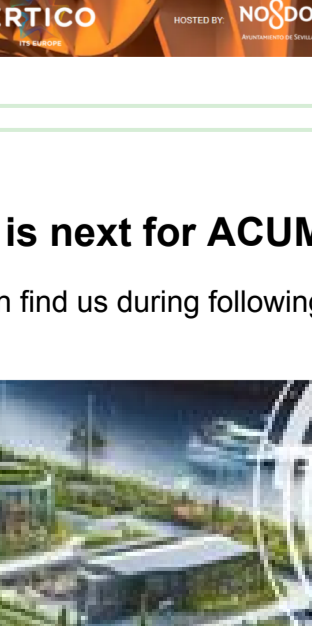
## Internal Meetings

The latest consortium meeting took place in Luxembourg in September. The meeting brought partners together to discuss challenges, review progress, and plan the project's next steps.



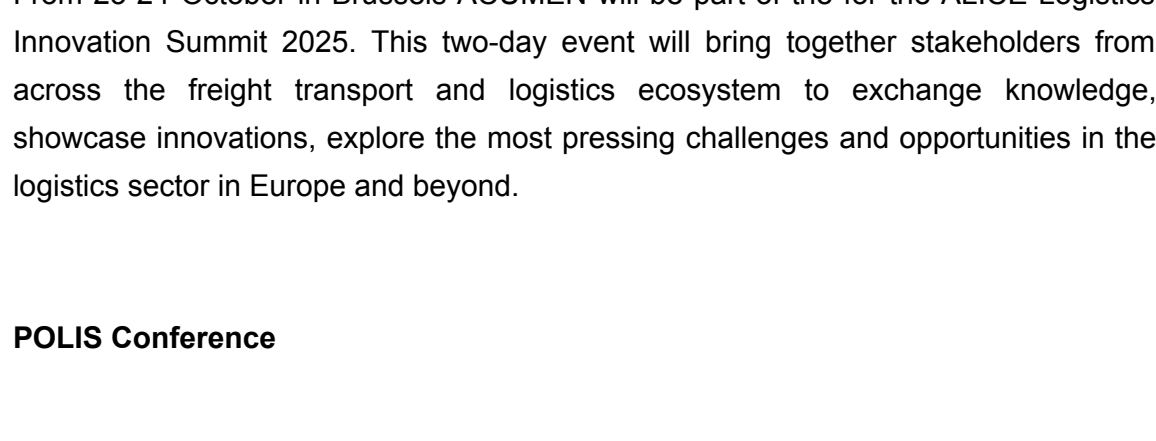
## Past Events

In order to disseminate our findings and engage with other projects and initiatives, we participated in several relevant events:



## What is next for ACUMEN?

In the following months you can find us during following events:



[Learn more](#)

### ALICE Innovation Summit

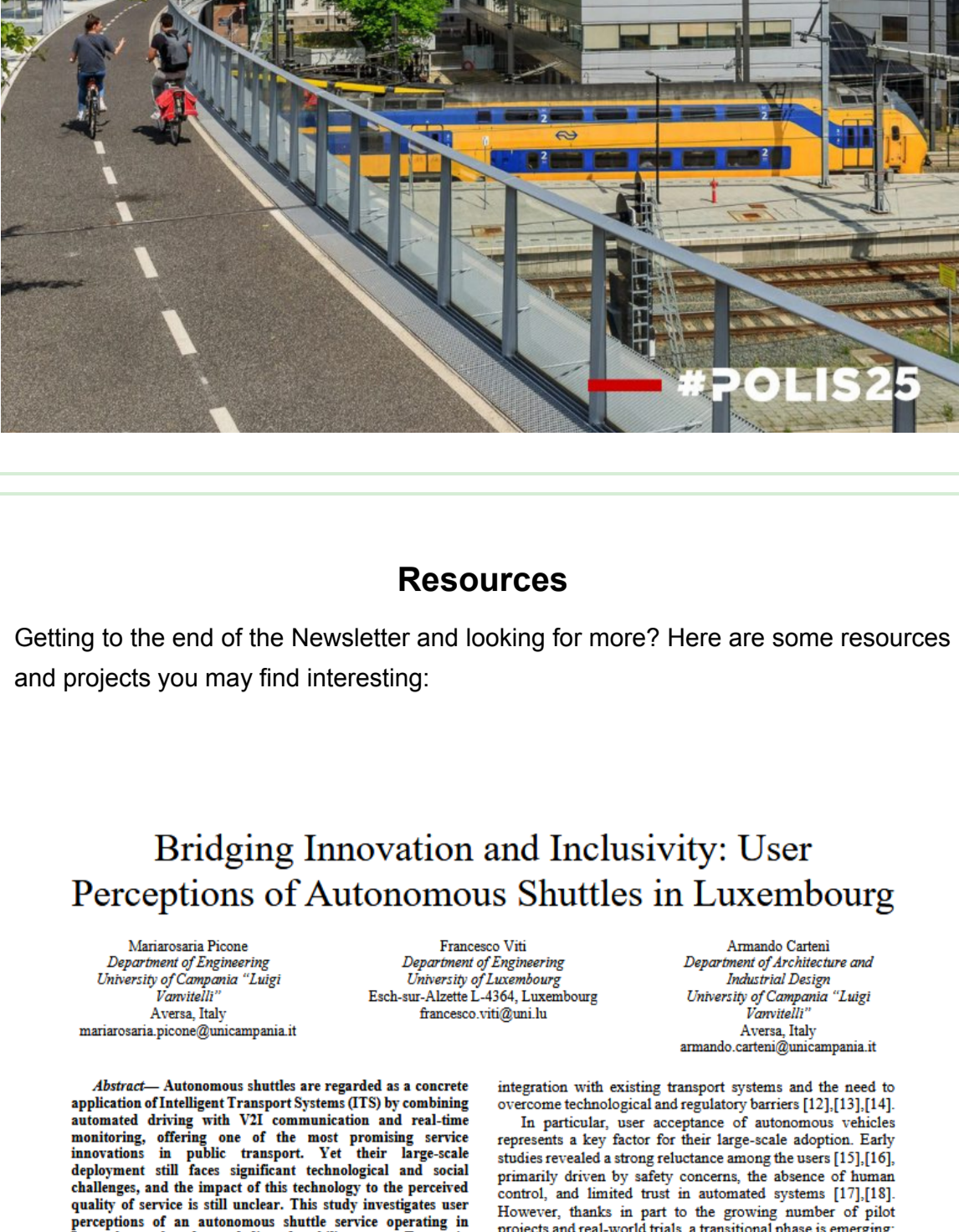
From 23-24 October in Brussels ACUMEN will be part of the for the ALICE Logistics Innovation Summit 2025. This two-day event will bring together stakeholders from across the freight transport and logistics ecosystem to exchange knowledge, showcase innovations, explore the most pressing challenges and opportunities in the logistics sector in Europe and beyond.

### POLIS Conference

ACUMEN will have a stand at the POLIS Conference, which will take place on 26 - 27 November in Utrecht, alongside other projects from the MTMC Cluster. This event

private sector decision-makers.

Learn more



### Resources

Getting to the end of the Newsletter and looking for more? Here are some resources and projects you may find interesting:

## Bridging Innovation and Inclusivity: User Perceptions of Autonomous Shuttles in Luxembourg

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**Abstract**— Autonomous shuttles are regarded as a concrete application of Intelligent Transport Systems (ITS) by combining automated driving with V2I communication and real-time monitoring, offering one of the most promising service innovations in public transport. Yet their large-scale deployment still faces significant technological and social challenges, and the impact of this technology to the perceived quality of service is still unclear. This study investigates user perceptions of an autonomous shuttle service operating in Luxembourg, based on a dedicated mobility survey. Two main findings emerge from the analysis. First, results highlight an ongoing transition phase toward the acceptance of this innovative autonomous driving technology. Although curiosity and interest in experiencing the service are evident, concerns about safety and reliability persist. In this context, the presence of an on-board supervisor emerges as a key factor in fostering user trust and improving service acceptability. Second, the survey data collection campaign revealed that the service is predominantly used by elderly individuals and people with reduced mobility, suggesting that autonomous shuttles hold significant potential to improve accessibility for these user groups, and hence can contribute to promote inclusive urban mobility. These insights can guide the future development of autonomous public transport services, supporting the design of solutions more closely aligned with the needs of vulnerable user groups and more widely accepted by the public.

**Keywords**— Shared Autonomous Vehicles (SAVs), Users perceptions, Accessibility and social equity, Sustainable and inclusive mobility.

integration with existing transport systems and the need to overcome technological and regulatory barriers [12], [13], [14].

In particular, user acceptance of autonomous vehicles represents a key factor for their large-scale adoption. Early studies revealed a strong reluctance among the users [15], [16], primarily driven by safety concerns, the absence of human control, and limited trust in automated systems [17], [18]. However, thanks in part to the growing number of pilot projects and real-world trials, a transitional phase is emerging: public familiarity with these technologies is increasing, along with the willingness to use them [19], [20]. The expansion of such pilot deployments not only offers users the opportunity to experience the service first-hand, helping to reduce mistrust and preconceived notions, but also provides valuable feedback to industry stakeholders, enabling continuous technological improvements, enhanced system reliability, and the development of increasingly efficient and user-oriented service models [21], [22].

Within this context, growing attention is being given to Shared Autonomous Vehicles (SAVs), which represent a specific application of AV technology combined with shared mobility principles. SAVs, including autonomous shuttles operating on predefined routes, are designed to complement existing public transport networks, improve first and last mile connectivity, and provide flexible, accessible transport options, especially in urban environments and pedestrian areas. These solutions are seen as particularly promising for supporting inclusive mobility and addressing the needs of those who face challenges using conventional transport.

This study focuses on a survey pilot project involving an autonomous shuttle service in Luxembourg, for which a survey was conducted among its users. The main objective is to analyze perceptions, strengths and weaknesses, as well as user satisfaction and travel behavior in relation to this innovative form of mobility. In addition, the research aims to better understand which user groups are most likely to access and benefit from such services. In particular, the analysis aims to identify those groups that benefit most from the use of autonomous shuttles, with a specific focus on the needs of elderly people and those with reduced mobility.

The paper is structured as follows: Section 2 provides an overview of the current state of the art, illustrating the evolution of autonomous mobility and the reference context. Section 3 describes the adopted methodology and data collection process. Section 4 presents and discusses the main findings. Finally, Section 5 summarizes the key conclusions, outlines the study's limitations, and proposes directions for future research.

### II. LITERATURE REVIEW

Pilot projects involving autonomous shuttles have experienced significant growth in recent years, with trials conducted in a variety of contexts [23]: from university

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## Bridging Innovation and Inclusivity: User Perceptions of Autonomous Shuttles in Luxembourg

This study examines user perceptions of an autonomous shuttle service in Luxembourg. Survey results show growing interest but persistent concerns about safety and reliability, with an on-board supervisor seen as essential for trust. The service is mainly used by elderly people and those with reduced mobility, highlighting its potential to improve accessibility and support inclusive urban mobility.

Learn more

### AI for Transport Authorities: Principles and Practical Guidance

Artificial intelligence (AI) is reshaping transport by improving efficiency and personalisation but also brings risks and governance challenges. Public authorities should assess when and how to use AI, ensuring alignment with their mandates, ethical standards and responsibilities. Effective risk management, continuous monitoring, and transparent communication are essential to maintain accountability and public trust.

Learn more



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