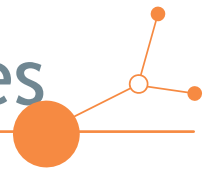




ACCESSMILE

Solutions topic 2: gates & entry/exit tools and procedures

Deliverable no. D.3.1.2



Version 2
05 2026

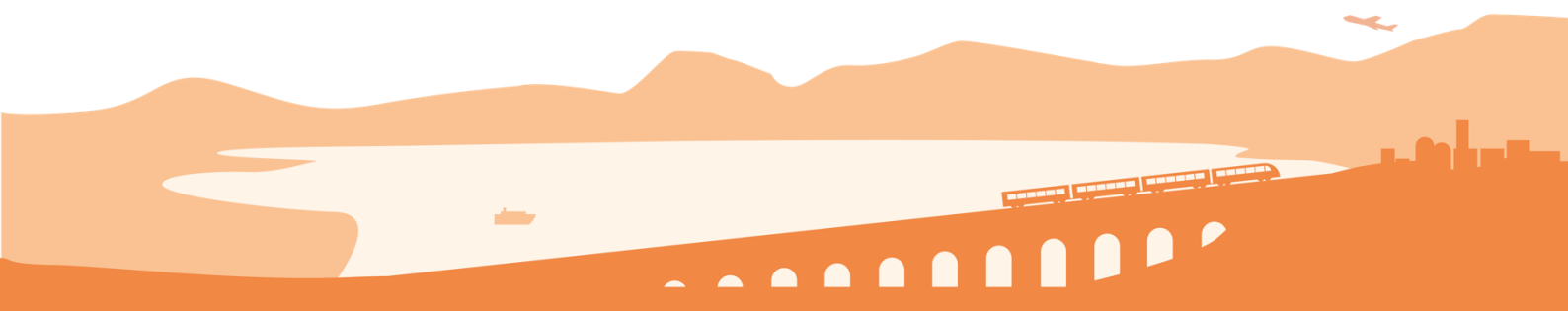




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1. Overview

This deliverable (D.3.1.2) provides the long-term sustainability guidelines for Solution No. 2 - Gates and Entry/Exit Tools and Procedures, jointly developed within the ACCESSMILE project. Topic 2 focuses on digitalisation and automation of gate processes, aiming to reduce congestion, improve safety, and streamline vehicle access at ports, terminals, freight villages, and rural/peripheral logistics nodes.

The solution brings together the results of five complementary pilot actions implemented by:

- PP2 - ZAILOG (Verona Freight Village) - Italy
- PP3 - Port of La Spezia / ADSPMLOR - Italy
- PP4 - Luka Koper - Slovenia
- PP8 - RSOE - Hungary
- PP9 - BCT Gdynia - Poland

Each pilot introduces ICT tools to modernise gate operations through automated identification, optical recognition, interlinked PCS/TOS data exchange, pre-registration systems, and automated weight controls. Together, these pilots form a transnational, scalable, and interoperable framework for enhancing last-mile logistics efficiency and improving the accessibility of rural and peripheral areas to TEN-T nodes.



2. SWOT analysis of ACCESSMILE pilot solution and adopted technical measures

Implementing a pilot solution introducing digital gate and entry/exit management solutions in all five sites faced many challenges, but on the other hand, it revealed many possibilities for improving this service and involvement of rural and peripheral areas. The forthcoming SWOT analysis provides a comprehensive overview of the implementation of Topic 2 - Gates and Entry/Exit Tools and Procedures, examining its Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T).

Strengths	Weaknesses
<ul style="list-style-type: none"> • Significant reduction of truck waiting and processing times • Automated data capture (OCR, WIM, digital interfaces) • Improved accuracy and security of gate operations • Demonstrated interoperability between PCS and TOS systems • Functional in both large maritime ports and inland terminals • Modular and scalable architecture 	<ul style="list-style-type: none"> • Heterogeneous digital maturity across sites • Need for staff training • Partial integration with customs systems in some contexts • Initial investment required for OCR and WIM equipment
Opportunities	Threats
<ul style="list-style-type: none"> • High replicability across TEN-T ports and inland nodes • Alignment with EU policies on smart ports and decarbonisation • Potential integration with AI-based traffic forecasting • Improved regulatory enforcement (weight, safety, documentation) 	<ul style="list-style-type: none"> • Risk of fragmentation without common standards • Resistance from operators accustomed to manual processes • Dependence on ICT vendors • Regulatory delays (e.g. WIM certification)

Table 1 - SWOT analysis of Topic 2 - Gates and Entry/Exit Tools and Procedures

The pilot phase confirmed that gate operations represent one of the most critical interfaces within the logistics chain.

The experiences gathered across the ACCESSMILE pilots demonstrated that targeted digital interventions at entry and exit points can generate significant operational benefits in terms of throughput, predictability and environmental performance. In particular, the deployment of OCR and WIM technologies showed that automation and regulatory control can be effectively combined without compromising operational efficiency.



Weaknesses and threats identified by the SWOT analysis need to be overcome in order to further develop the pilot solution. For this purpose, potential measures were identified in the table below.

Key issues from the SWOT analysis		Potential measures to overcome weaknesses and threats	Expected effects
1.1.	Different IT maturity levels	Provide common API standards, shared protocol documentation, and modular deployment kits.	Higher interoperability; smoother gate automation.
1.2.	Training needs	Regular training sessions and ICT workshops for operators and SMEs.	Higher efficiency, fewer errors, stronger uptake.
1.3.	Limited integration with customs	Promote cross-agency data-sharing agreements and standardised e-documents.	Faster clearance and reduced queues.
1.4.	Initial investment for hardware	Seek EU/national grants and shared funding models.	Lower financial burden for smaller terminals.
1.5.	Risk of fragmentation	Establish shared governance and common technical guidelines.	Harmonised deployment across Central Europe.
1.6.	Resistance from operators accustomed to manual processes.	Implement structured change-management programmes, including awareness campaigns, hands-on training, and on-the-job coaching; involve frontline operators in the co-design of procedures; introduce phased deployment with pilot phases and feedback loops.	Higher user acceptance and trust in the new systems, smoother transition from manual to digital procedures, fewer operational errors, and a more stable use of automated gate tools.
1.7.	Dependence on external ICT vendors for updates	Promote the use of open standards and documented APIs; negotiate clear SLAs and long-term maintenance contracts; gradually build internal ICT capacity to manage basic configurations; diversify suppliers where possible to avoid single-vendor lock-in.	Reduced vulnerability to vendor lock-in, higher continuity of service, better control over lifecycle costs, and increased flexibility to adapt systems to evolving operational needs.
1.8.	Regulatory delays for certification of technologies (e.g., WIM).	Engage early with competent authorities and standardisation bodies; use pilot projects to generate evidence and share results with regulators; participate in national and EU working groups on WIM and digital enforcement; align project specifications with emerging legal and technical standards.	Shorter and more predictable certification processes, earlier large-scale deployment of WIM and related technologies, and greater legal certainty for operators and authorities using digital gate solutions.

Table 2 - Possible measures to overcome identified key weaknesses and threats



3. Long-term sustainability goals and strategies of the pilot solution

Three long-term sustainability goals have been identified for the continuation and scaling of the gate and entry/exit improvements. Three long-term sustainability goals have been identified for the continuation and scaling of the gate and entry/exit improvements.

No.	Long-term sustainability goals	Proposed strategies for implementation of goals	Expected long-term impact
G1	Maintain and expand the digital gate systems	<ul style="list-style-type: none"> □ Integrate OCR, WIM, and access apps into national or port digitalisation plans. □ Ensure continuous updates to TOS/PCS interfaces (e.g., I-TOS upgrades in Verona). □ Standardise gate data formats across terminals. 	Improved gate efficiency, safer operations, higher accuracy of data, and reduced emissions.
G2	Promote uptake among logistics operators and authorities	<ul style="list-style-type: none"> □ Disseminate replication guidelines, documentation, and training modules. □ Organise workshops within Central Europe for terminal operators and SMEs. □ Encourage rural and peripheral transportation companies to adopt digital gate pre-registration. 	Broader adoption of automated gate systems, improved accessibility, and fewer bottlenecks in rural areas.
G3	Strengthen cross-border institutional cooperation and policy alignment	<ul style="list-style-type: none"> □ Establish a coordinated forum for OCR, WIM, PCS, and TOS operators. □ Promote alignment on safety, security, and digital data standards. □ Develop shared KPIs (waiting time, throughput, CO₂ reduction). 	Reliable interoperability, increased resilience, and harmonised digital gate operations across borders.

Table 3 - Proposed strategies to provide long-term continuation of gate and entry/exit improvements



3.1. Hints for continuation & extension of the solution

The continuation and extension of the solutions developed under Topic 2 rely on consolidating the operational achievements of the pilot phase and embedding the implemented tools into long-term port, terminal, and regional digitalisation strategies.

The five pilot sites demonstrated that gate automation can be introduced through a modular approach, adaptable to different scales of operation and levels of digital maturity. The key principle for continuation is not uniformity of technology, but interoperability and scalability.

At the Verona Freight Village (ZAILOG), the upgrade of the I-TOS platform shows how digital optimisation of existing systems can generate significant improvements without major physical infrastructure investments. The extension of such upgrades to other inland terminals can improve document handling, traceability, and gate management in freight villages located in rural or peripheral areas.

In La Spezia, the integration between the Port Community System and the Trucking Federative Platform offers a transferable model for port-dry port networks. Real-time coordination of shuttle services and enhanced visibility of truck movements can be replicated in other corridor-based logistics systems seeking better hinterland integration.

At the Port of Koper, the OCR system installed at the Bertoki entrance represents a concrete example of how a pilot investment can be embedded within a broader traffic reorganisation strategy. The Bertoki gate has been designated for container traffic redirected away from urban areas, in line with agreements between the port and local authorities. With daily peaks reaching up to 2,000 trucks, the automation of identification procedures is essential to prevent congestion. The operational comparison between OCR and traditional RFID-based lanes confirmed faster processing times, improved data accuracy, enhanced security control, and reduced operational burdens linked to badge management. The system is already mounted and operational in one entrance lane and forms part of a larger-scale infrastructure and traffic management upgrade. This demonstrates that OCR-based gate systems are mature, scalable, and suitable for high-growth TEN-T nodes.

The solution developed by RSOE, through the truck pre-registration module integrated into Hungary's national KIR platform, demonstrates that even terminals with lower IT maturity can adopt lightweight digital tools to improve gate coordination. The national scalability of this system makes it particularly suitable for inland and Danube ports serving peripheral regions.

The Weight-In-Motion (WIM) system implemented in Gdynia provides a model for exit gate enforcement in maritime terminals. Automated weight control enhances safety, regulatory compliance, and infrastructure protection without slowing down operations. Once certification frameworks are harmonised, this solution can be extended to additional TEN-T ports and multimodal hubs.

Looking ahead, the coordinated continuation of these technologies could lead to the progressive establishment of a Central European Smart Gate framework. Such a framework would be based on:

- Shared data standards
- Interoperable PCS/TOS interfaces
- Modular deployment of OCR, WIM, and digital pre-registration tools
- Common KPIs for monitoring waiting times, throughput, and environmental performance

The extension of Topic 2 solutions should therefore focus on gradual scaling, interoperability, and institutional coordination, ensuring that digital gate automation contributes not only to operational efficiency but also to improved accessibility of rural and peripheral areas to the TEN-T network.

Lessons learned from the pilot implementation highlighted that interoperability and modularity are essential conditions for long-term scalability. The pilots demonstrated that digital gate technologies should not be



deployed as isolated systems, but integrated into wider operational and governance frameworks involving PCS, TOS, customs procedures and traffic management systems.

The pilot phase also confirmed that replication should follow a gradual and adaptive approach. Different logistics nodes require different combinations of technologies and operational procedures depending on traffic volumes, infrastructure characteristics and organisational maturity.

4. Financial indications related to the long-term sustainability

The long-term financial sustainability of the Topic 2 solutions is supported by their integration into the ordinary ICT and infrastructure investment plans of the participating ports and terminals.

In most cases, the solutions implemented under ACCESSMILE – including OCR systems, WIM equipment, TOS upgrades, PCS integrations, and digital pre-registration tools – are not stand-alone experimental technologies, but components embedded within broader digitalisation and traffic management strategies.

At the Port of Koper, for example, the OCR system installed at the Bertoki gate is part of a wider traffic reorganisation and infrastructure upgrade. While ACCESSMILE co-financed one OCR unit, the overall investment framework includes additional lanes and traffic management measures to ensure continuity beyond the project duration. This approach reduces the financial risk of pilot discontinuity and demonstrates institutional commitment to long-term deployment.

Similarly:

- In Verona, the I-TOS upgrades are incorporated into the regular evolution of the terminal operating system, with maintenance costs falling within existing ICT budgets.
- In La Spezia, the integration between PCS and trucking platforms is aligned with the port authority's broader digital transformation roadmap.
- In Hungary, the RSOE pre-registration module is embedded within the national KIR system, ensuring institutional support and national-level sustainability.
- In Gdynia, the WIM system forms part of a long-term strategy to strengthen weight enforcement and infrastructure protection at exit gates.

From a cost perspective, long-term expenditures mainly concern:

- Periodic technical maintenance of hardware components (OCR portals, WIM sensors, cameras)
- Software updates and cybersecurity management
- ICT system integration and interoperability adjustments
- Training of operational staff

These costs are predictable and can be incorporated into annual maintenance budgets.

For further replication and scaling, a combination of funding sources may be mobilised, including:

- European programmes (Interreg, CEF, Horizon Europe) supporting digitalisation, interoperability, and environmental objectives
- National innovation and port modernisation funds
- Public-private co-financing models
- Service-based contributions where value-added digital services are introduced

A balanced financial model can foresee:



- Terminal operators covering operational maintenance of physical equipment
- Port authorities' financing system integration and digital infrastructure upgrades
- National authorities supporting tools that deliver public-interest benefits (e.g., safety, emissions reduction, regulatory enforcement)

Overall, the financial sustainability of Topic 2 solutions is strengthened by their integration into strategic port development plans and digital transition frameworks. The modular architecture of the implemented systems allows incremental expansion without requiring disruptive or large-scale one-off investments, making the solution economically viable for both major TEN-T nodes and smaller terminals located in rural and peripheral areas.

5. Recommended pilot solution governance schemes

To ensure the long-term continuity and coherent expansion of the Topic 2 solutions, an appropriate governance framework is essential. Gate automation systems such as OCR, WIM, TOS upgrades, PCS integrations and digital pre-registration tools require not only technical maintenance, but also coordinated institutional oversight and strategic alignment.

At local level, each port or terminal should rely on an integrated coordination mechanism involving port authorities, terminal operators, ICT providers, customs and enforcement bodies (where relevant), and traffic management units. This structure should oversee system maintenance, ICT updates, interoperability with PCS/TOS platforms, cybersecurity management, and the monitoring of operational performance indicators such as waiting times and throughput. Embedding these digital tools within existing operational governance structures avoids the creation of parallel management layers and ensures institutional continuity beyond the project lifecycle.

In cases such as the Port of Koper, where the OCR system installed at the Bertoki gate is part of a broader traffic reorganisation strategy, governance must also include coordination with municipal authorities and alignment with national infrastructure planning. This demonstrates that gate automation should not be treated as a purely technical upgrade, but as an integrated component of traffic management and TEN-T corridor development strategies. Similarly, in Verona, La Spezia, Hungary and Gdynia, the implemented solutions are embedded within existing port or national digital systems, reinforcing long-term sustainability.

Beyond local governance, continued transnational coordination is recommended to preserve interoperability and harmonised development across Central Europe. A structured but flexible coordination mechanism—such as periodic technical exchanges or working groups—can facilitate knowledge-sharing, alignment of technical standards, exchange of regulatory updates (for example in relation to WIM certification), and benchmarking of performance indicators. This reduces the risk of fragmentation and supports gradual scaling across additional TEN-T nodes.

The governance framework should be guided by key principles: modularity (allowing incremental expansion of systems), interoperability (ensuring compatibility across platforms), standardisation (promoting shared data formats and APIs), institutional anchoring (embedding systems in official digital and mobility strategies), and active involvement of logistics operators and SMEs to secure acceptance and usability.

Overall, a balanced governance approach—combining strong local operational responsibility with coordinated transnational alignment—will ensure that the Topic 2 solution remains technically reliable, strategically coherent and scalable across diverse logistics environments, including rural and peripheral areas connected to the TEN-T network.

The mutual learning workshop discussions carried out within ACCESSMILE confirmed that governance is a decisive success factor for digital gate automation. Beyond technical maintenance, successful long-term



operation requires coordinated procedures, clear institutional responsibilities and continuous stakeholder engagement. The pilot experience demonstrated that ports and terminals achieving the highest operational improvements were those where technological deployment was accompanied by strong alignment between operational actors and governance structures.

6. Recommendations and suggestions for the replication of the pilot solution beyond the pilot area

The solutions developed under Topic 2 are suitable for replication across a wide range of logistics contexts, including maritime ports, dry ports, inland terminals, freight villages and multimodal hubs located along TEN-T corridors as well as in rural and peripheral regions.

Replication should begin with a structured assessment of existing gate procedures and operational bottlenecks. Terminals should identify whether inefficiencies stem from manual identification processes, lack of data integration between ICT systems, weight-control gaps, documentation delays, or unpredictable truck arrivals. Based on this assessment, the most appropriate technological module—OCR systems, WIM equipment, TOS upgrades, PCS integration or digital pre-registration tools—can be selected and adapted to local needs.

The modular nature of the Topic 2 solution allows replication to occur progressively. For example:

- OCR systems, such as the one implemented at the Bertoki gate in Luka Koper, can be deployed in high-volume TEN-T nodes facing congestion and traffic reorganisation challenges, especially where heavy vehicle flows must be managed outside urban areas. The proven comparison between automated OCR recognition and traditional RFID-based procedures demonstrates that such systems are suitable for ports experiencing growing container traffic.
- TOS upgrades, as implemented in Verona, can be replicated in inland freight villages and smaller terminals where digital optimisation of existing systems can significantly improve document management, traceability, and gate coordination without requiring major physical infrastructure investments.
- PCS-Trucking integration, as demonstrated in La Spezia, can be adopted in port-dry port networks seeking enhanced real-time visibility and coordination of shuttle services.
- Digital pre-registration modules, such as the RSOE solution integrated into the Hungarian KIR platform, are particularly suitable for terminals with lower IT maturity, offering cost-effective and scalable access management.
- WIM systems, as implemented in Gdynia, provide a replicable model for automated weight enforcement at exit gates, contributing to infrastructure protection, safety and regulatory compliance.

Successful replication requires careful attention to interoperability. New systems should be compatible with existing PCS and TOS environments, based on open standards and clearly documented APIs. This reduces integration costs and avoids vendor lock-in.

Operator training and stakeholder engagement are equally important. Transport companies, terminal staff, and enforcement authorities should be involved early in the replication process to ensure acceptance and correct use of digital tools. Structured change-management processes can significantly improve adoption rates.



Performance monitoring through clearly defined KPIs—such as waiting time reduction, throughput increase, weight compliance rates, and emission reduction—will further support optimisation and evidence-based scaling decisions.

Priority for replication should be given to logistics nodes located in Central and Eastern Europe, where digital gate automation can substantially improve accessibility to TEN-T corridors for rural and peripheral regions. However, the modular and interoperable design of the Topic 2 solution makes it transferable beyond the Central European context.

The ACCESSMILE pilot phase demonstrated that successful replication depends not only on transferring technologies, but also on adapting operational workflows, organisational responsibilities and user practices to local conditions. Replication should therefore combine technological deployment with training activities, stakeholder involvement and progressive implementation phases to ensure operational acceptance and effective uptake.



7. Conclusion. ACCESSMILE jointly developed solution to be taken up / upscaled.

The jointly developed solution under Topic 2 represents a mature, operational, and scalable framework for the digitalisation and automation of gate and entry/exit procedures across ports, inland terminals, and logistics hubs in Central Europe.

Although each pilot site implemented different technological modules—OCR systems, WIM equipment, TOS upgrades, PCS-Trucking integration and digital pre-registration tools—the partners worked within a shared methodological approach aimed at improving efficiency, safety, interoperability, and accessibility. The pilots collectively addressed structural challenges common to many logistics nodes: congestion at gates, manual verification processes, documentation inconsistencies, limited ICT integration, and safety risks linked to paper-based or badge-based procedures.

The implementation phase confirmed that targeted investments in digital gate automation generate measurable operational benefits. Reduced waiting times, improved data accuracy, enhanced regulatory compliance and smoother traffic flows contribute not only to terminal performance but also to broader territorial accessibility and environmental objectives.

The experience of Luka Koper illustrates the maturity and scalability of the solution. The OCR system installed at the Bertoki entrance is operational and integrated into a wider traffic reorganisation strategy that redirects heavy vehicle flows away from urban areas. Managing daily peaks of up to 2,000 trucks, the system replaces manual and RFID-based identification with automated recognition of license plates, container numbers, seals, and hazard markings. The operational comparison between OCR and traditional RFID procedures confirms improved processing speed, higher data reliability, and strengthened security controls. Situated on three TEN-T Core Network corridors, this deployment demonstrates how digital gate solutions can support strategic port expansion and corridor competitiveness.

Similarly, the upgrades implemented in Verona, La Spezia, Hungary, and Gdynia demonstrate that digital gate solutions can be adapted to different operational scales and levels of digital maturity. From inland freight villages to major maritime ports, the modular architecture of Topic 2 allows progressive expansion and integration into existing ICT systems.

From a territorial perspective, the jointly developed solution strengthens accessibility for rural and peripheral areas by making connections to TEN-T corridors more predictable and reliable. Faster and more transparent gate procedures reduce uncertainty for transport operators, improve turnaround times, and support modal shift towards more sustainable intermodal transport solutions.

The solution is therefore ready for uptake and upscaling. Its modular design allows incremental deployment in additional gates and terminals, while shared governance principles and interoperability standards ensure coherent development across borders. By embedding digital gate automation within national port strategies, regional mobility plans, and EU digital transition frameworks, the Topic 2 solution can contribute meaningfully to the long-term efficiency, safety, and sustainability of the European logistics system.

Overall, Topic 2 demonstrates that digital transformation at terminal gates is not merely a technological upgrade, but a strategic enabler of resilient, interoperable, and environmentally responsible freight transport networks.

The pilot phase also highlighted the strategic value of transnational cooperation. The exchange of operational experiences among ports, terminals and logistics stakeholders allowed partners to refine solutions, identify transferable practices and reduce implementation risks. This transnational learning process significantly strengthened the robustness and replicability of the jointly developed solutions.



ACCESSMILE Solution Topic.2: Gates and Entry/Exit Tools and Procedures	
Final users/target groups	Terminal operators, port authorities, customs and border police, freight forwarders, trucking companies, railway undertakings, ICT providers, operators in rural and peripheral areas, and cargo owners who rely on efficient and predictable gate operations.
Final user needs addressed	More efficient and faster gate procedures; reduced waiting times and queues; enhanced reliability and predictability of access operations; increased safety and security; reduction of CO ₂ emissions from idling; streamlined documentation handling; improved access for rural and peripheral regions.
Co-design process (involved partners and country involved)	The solution was co-designed by PP2 ZAILOG (Italy), PP3 ADSPMLOR La Spezia (Italy), PP4 Luka Koper (Slovenia), PP8 RSOE (Hungary), and PP9 BCT Gdynia (Poland). Collaboration took place through joint technical meetings, bilateral exchanges, peer-review sessions, and Steering Committee discussions, allowing partners to compare gate management challenges, align on functional requirements, and ensure methodological consistency.
Uptake strategy	Uptake is supported by tangible benefits observed in all pilots, including reduced congestion, faster truck turnaround, improved coordination, and lower fuel consumption. The solutions are designed to be modular and cost-effective, enabling adoption in digitally advanced terminals as well as in rural and peripheral sites. Capacity-building activities, technical guidelines and dissemination actions will further encourage uptake across Central Europe.
Upscaling Strategy	The modular architecture of the Topic 2 solutions allows incremental expansion to additional gates or terminals. OCR systems can be deployed in multiple port gates, I-TOS upgrades replicated in inland freight villages, PCS-Trucking integration extended across port-hinterland corridors, and the RSOE pre-registration module adopted throughout the Danube network. The WIM solution offers a scalable model for weight enforcement in other TEN-T ports. Upscaling will rely on shared data standards, coordinated governance, and alignment with EU digital transport policies.

Table 4 - ACCESSMILE Topic 2. up-scaling strategy

Following the synthesis provided in the table, the Topic 2 solution demonstrates a high level of operational readiness and transferability. The pilots collectively confirmed that the challenges addressed—manual verification at gates, congestion during peak hours, documentation inconsistencies, limited ICT integration and safety concerns—are common across European logistics nodes. This reinforces the relevance and replicability of the jointly developed solution.



The collaborative approach adopted within ACCESSMILE has ensured interoperability, technical robustness and adaptability to different operational scales. From high-volume maritime ports such as Luka Koper to inland terminals and Danube ports, the solution has proven capable of supporting both advanced digital environments and contexts with lower IT maturity.

The ability to combine OCR systems, WIM equipment, TOS upgrades, PCS integrations, and digital pre-registration tools under a shared governance and interoperability framework demonstrates that digital gate automation can become a structural component of modern logistics systems rather than a stand-alone technological upgrade.

Looking ahead, the continued alignment of standards, data models, and governance mechanisms will be essential to ensure coherent expansion across the Central European transport network. Under these conditions, the Topic 2 jointly developed solution is well positioned to contribute to the digital transformation of freight transport, strengthening efficiency, safety, environmental performance, and last-mile accessibility to the TEN-T corridors.