

Preparing the ground for **AUTO**nomous Multimodal **SUP**ply Chains

Grant Agreement Number: 101147468



D1.2. SEAMLESS MULTIMODAL AUTOMATIC FREIGHT TRANSPORT REQUIREMENTS

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Executive Summary

Deliverable D1.2 Seamless Multimodal Automatic Freight Transport Requirements is part of the AUTOSUP project, which aims to prepare the ground for the deployment of autonomous and automated solutions in multimodal freight transport across Europe. So D1.2 aims to define key requirements for enabling the seamless integration of automation technologies within multimodal supply chains, ensuring interoperability across systems and modes, addressing human-machine interactions, safety, security and regulatory aspects, and creating the foundation for future deployment at large scale, by collecting, structuring, and consolidating operational requirements, based on consideration from the industry sector and real-world insights. The work carried out included a comprehensive stakeholder engagement process consisting of two major L-Hubs' workshops and a series of targeted interviews. The first workshop was held in Antwerp (Belgium) at the VIL premises, and it focused on five key thematic areas. The second workshop, held in Trieste (Italy), followed a more open discussion format, using the Antwerp workshop's results as a starting point for validation and deeper analysis, allowing for the identification of additional specific issues. Complementing these workshops, semi-structured interviews were conducted with external experts and representatives from logistics associations and platforms to provide deeper insights into technical, regulatory, and organizational challenges and requirements

The innovations this work introduces lie in the structured approach to collecting requirements through living hubs and stakeholder involvement, combining formal discussion tools (the thematic areas) with open dialogue formats to validate and refine results (interviews), taking into consideration most of the results achieved so far from the project, basically the deliverable D1.1 on the classification of automations, and the use case scenarios and KPIs definition in the deliverable D1.3, under development, to ensure consistency and practical relevance. This allowed for the identification of cross-cutting requirements, applicable across transport modes and logistics environments. The main conclusions show that achieving seamless multimodal automation requires action in several areas:

- Stronger interoperability and standardization frameworks are needed, particularly for data exchange and system integration across modes and IT platforms.
- Legal and cybersecurity aspects must be addressed through updated regulations, certification processes for integrated systems, security measures, and clear liability frameworks for automated operations.
- Significant attention must be given to human factors, including workforce upskilling, change management, and resistance mitigation, particularly in union-influenced environments.
- Financial sustainability and long-term return on investment are critical drivers; early adoption incentives and scalable funding models are desirable to foster automation uptake.
- Collaboration and trust between stakeholders remain key challenges; governance frameworks, shared risk-reward models, and common data spaces will play a fundamental role.

The findings from this deliverable will feed into the definition of operational models (WP3), the design of the Digital Twin of the autonomous multimodal supply chain (WP2), and the strategic alliance and roadmap activities (WP4).



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Glossary & Acronyms

Table 1-1: Glossary

TERM	DEFINITION
Automation	The use of technology to perform tasks with minimal human intervention.
Canvas	A structured discussion tool used to collect insights and contributions from stakeholders on specific topics.
Cobots	Collaborative robots, designed to work safely alongside humans. Unlike traditional robots, they share the same workspace and assist with repetitive or physically demanding tasks, such as lifting or packing, especially in warehouses.
Contingency Planning	Preparing backup solutions to ensure system continuity in case of disruptions.
Exoskeletons	Wearable devices that support and enhance workers' physical capabilities, reducing strain during tasks like lifting or carrying in warehouses.
Interoperability	The ability of systems, platforms, or devices to work together and exchange data effectively without restrictions.
Living Hub	A real-world testing environment where project activities and stakeholder engagement are conducted to validate solutions.
Multimodal transport	The transportation of goods using two or more different modes (road, rail, inland waterways, sea) under a single transport chain.
Quality	Degree to which a set of inherent characteristics of an object fulfils requirements
Robots	Automated machines used in warehouses to perform tasks such as sorting, transporting, or stacking goods, improving speed and efficiency.
Stakeholder	Any individual or organization with an interest or role in logistics and supply chain processes.

Table 1-2: List of Acronyms

ACRONYM	DEFINITION
AI	Artificial Intelligence
AUTOSUP	Preparing the ground for AUTOnomous Multimodal SUPply Chains (Project name)
CA	Consortium Agreement
DSS	Decision Support System
DT	Digital Twin
eFTI	Electronic Freight Transport Information
ETP-ALICE	Alliance for Logistics Innovation through Collaboration in Europe
GA	Grant Agreement
HMI	Human-Machine Interaction
IoT	Internet of Things
IT	Information Technology
IWT	Inland Waterways Transport
KPI	Key Performance Indicator
TMS	Transportation Management System
UC	Use Case
WP	Work Package



1 Introduction

1.1 Addressing the AUTOSUP Description of Action

AUTOSUP GA Item/Requirement	Description of the item/requirement	Deliverable chapter(s)	Brief description
D1.2 – Seamless multimodal automatic freight transport requirements	This deliverable focuses on identifying and structuring the key technical, operational, regulatory, and organizational requirements for enabling seamless automation in multimodal freight transport chains.	Chapters 2, 3, and 4	The deliverable presents the approach (methodology), the results from stakeholder engagement (workshops and interviews), and consolidates identified requirements into thematic areas, addressing technical, human, economic, and regulatory aspects.
T1.2 – Identification of operational automation requirements	Task 1.2 aims to define requirements for the automation of multimodal transport operations based on real-world needs, challenges, and stakeholder input.	Chapters 3 and 4	Requirements were identified through two dedicated workshops (Antwerp and Trieste) and validated via interviews. The results were categorized and grouped to reflect cross-cutting needs for future implementation.
T1.3 – Use case scenarios and KPIs (draft)	To support the requirement definition, task 1.3 provides use cases and draft KPIs to structure discussions and contextualize stakeholder feedback.	Chapter 3 (references to use cases)	The Antwerp workshop leveraged use case scenarios defined in T1.3 to guide discussions on interoperability, integration, and automation impacts. These were used as reference points to ensure practical relevance.

1.2 Overview and Structure of the Document



Chapter 2 introduces the context and outlines the methodology used to develop this deliverable, including workshops and interviews with stakeholders.

Chapter 3 presents the results from the two key workshops held in Antwerp and Trieste and the expert interviews. It summarizes stakeholder input on key themes: interoperability, human-machine interaction, cybersecurity and legal aspects, cost-benefit analysis, and supply chain collaboration.

Chapter 4 consolidates all the collected requirements, organizing them by cross-cutting themes and highlighting the most relevant challenges and needs for automation implementation.

Chapter 5 outlines conclusions and recommendations for future work, including how these results will feed into subsequent project activities and deliverables.



2 Framing the automation in the AUTOSUP contexts

In today's fast-evolving logistics landscape, automation is no longer a futuristic concept; but a present reality transforming how goods move through supply chains. Automation refers to using advanced software and hardware technologies such as robotics, artificial intelligence (AI), the Internet of Things (IoT), and autonomous vehicles to perform tasks traditionally handled by humans, such as sorting packages, planning delivery routes, or managing inventory. While these technologies are already in use, they often operate in isolated "silos" where individual automations are functioning independently rather than as a cohesive, interconnected system along the supply chain. This disconnection limits efficiency, creates bottlenecks, and prevents the logistics industry from fully realizing the potential of automation.

There is a need to embrace automation more holistically and strategically, breaking down these silos making sure the specific automations in parts of the supply-chain, in logistics activities and during the transport, are well integrated in the operations without delays or inefficiencies and in a safe way. Today, this step is not just an option, but it is a necessity. On the hardware side, technologies such as robotics, IoT-enabled sensors, and autonomous/remotely controlled vehicles provide the physical tools to execute tasks with precision and scale. On the software side, innovations like cloud computing, AI-driven analytics, and real-time data platforms offer the intelligence and connectivity to orchestrate these systems effectively. These advancements establish a technological foundation that makes this leap possible for modern logistics.

Ok, but what's the primary benefit of using automation? Among the others, it significantly boosts capacity across logistics nodes (terminals, warehouses, and yards) without requiring expensive, time-consuming infrastructure expansions. Unlike traditional methods that involve expanding the terminal areas, automation maximizes existing resources through efficiency and technology in a short time. For instance, automated cranes accelerate container handling, while robotics in warehouses increase order processing within the same space. Autonomous vehicles and AI-driven planning further enhance throughput by minimizing delays and optimizing space. This delivers higher capacity fast and cost-effectively, meeting demand without the disruption of construction.

To fully realize the potential of automation and achieve a seamless, intermodal supply chain, it is critical to define the specific requirements that will guide its implementation. Within the AUTOSUP project, a key objective is to establish these requirements through a structured, evidence-based approach, leveraging real-world feedback from diverse stakeholders.

This process relies heavily on insights gathered from workshops and expert interviews. Two key workshops were conducted in the project's Living Hubs: Antwerp (Belgium) and Trieste (Italy). These locations were selected because they face similar challenges that we believe can be overcome through the automation of specific operations, representing major multimodal transport nodes connecting road corridors, rail and inland waterways. The Antwerp workshop, hosted by VIL (Flanders Logistics Cluster) on September 27th, 2024, brought together project partners, logistics operators, and external experts to explore automation needs and barriers. Similarly, the Trieste workshop, held on December 10th, 2024, at the MIB Trieste School of Management, engaged stakeholders to assess automation scenarios specific to its port and intermodal connections. These sessions provided practical perspectives on operational challenges, technological gaps, and opportunities for integrating automation across transport modes.

Complementing the workshops, targeted interviews were conducted exclusively with external experts and associations to gain detailed insights into the technical, operational, and regulatory requirements for automation. Contributions came from logistics associations, industry platforms and logistics nodes.



The results will be disseminated through follow-up engagement activities in WP4, targeting various stakeholders within the logistics and transport ecosystem, further refining and enhancing the findings. This comprehensive approach ensures that the automation requirements defined by AUTOSUP are both practical and forward-looking, paving the way for a fully automated intermodal supply chain.

2.1 Methodology

The methodology employed for the development of Deliverable D1.2, titled "Seamless Multimodal Automatic Freight Transport Requirements" which is one of the first deliverables of the AUTOSUP Project. It is under the responsibility of ALICE and follows a structured and evidence-based approach. Its primary objective is to define the necessary requirements for achieving seamless automation within multimodal freight transport systems, and to accomplish this. The project team prioritized direct engagement with individuals possessing in-depth knowledge of logistics operations, namely the stakeholders themselves, both at the local and EU level.

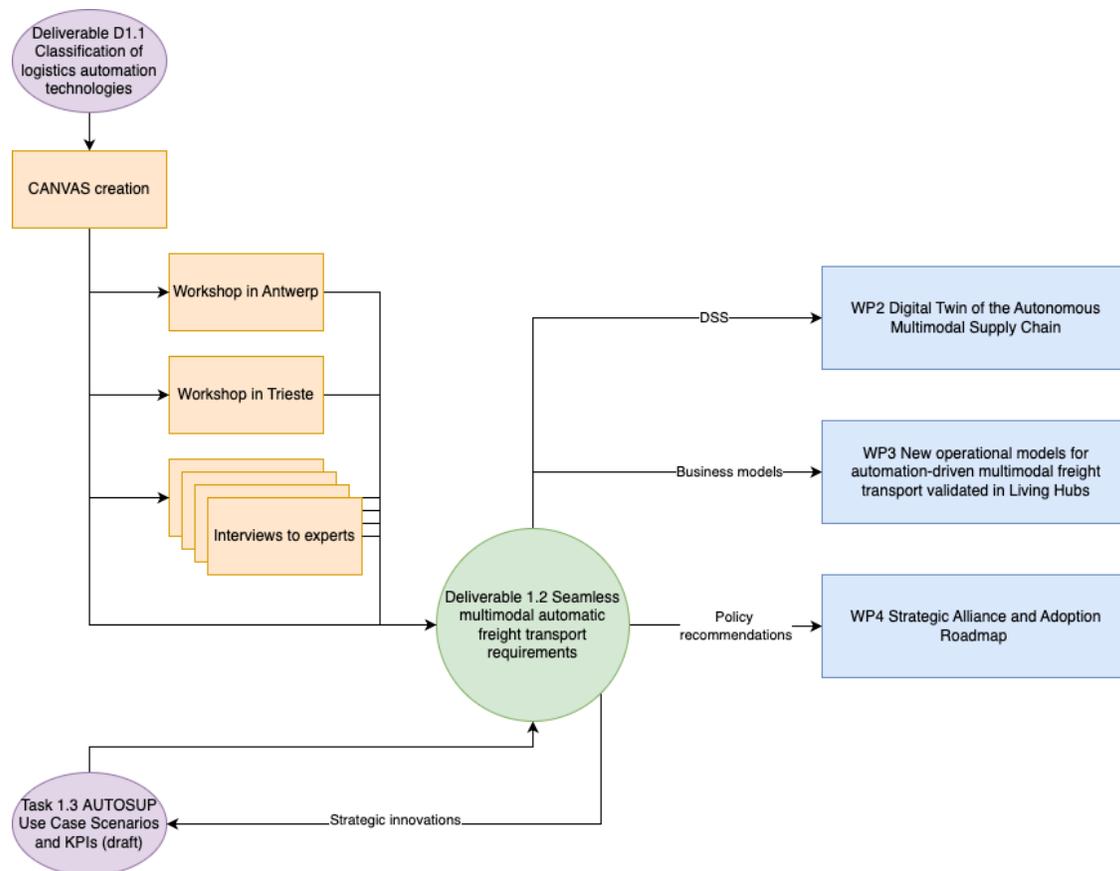


Figure 2-1: The methodology of D1.2

The core of this methodology relies on collecting real-world feedback from diverse stakeholders, and the two principal methods utilized for this purpose were workshops and expert interviews. These activities were designed to explore the needs and challenges associated with automation from various perspectives within the logistics and transport ecosystem.

Two key workshops were conducted in the project's Living Hubs:

- The first workshop took place in Antwerp (Belgium) on September 27th, 2024. It was hosted by VIL (Flanders Logistics Cluster), with the main aim of exploring automation needs and identifying existing barriers to its adoption, by bringing together project partners, logistics operators, and external experts to share their experiences and insights. Discussions during this workshop were notably informed by the "classification of logistics automation technologies detailed in Deliverable D1.1", which provided a crucial reference for analyzing challenges related to the integration and interoperability of different automation levels and categories. Furthermore, "Use case scenarios," defined in D1.3 were also presented to help focus the stakeholder discussions, albeit limited to the AUTOSUP use cases.
- The second major workshop was held in Trieste (Italy) in December 2024. Similar to the Antwerp workshop, the objective was to identify key requirements and challenges concerning logistics automation across the different thematic areas. The discussions in Trieste also built upon the foundation laid by Deliverable D1.1 and the presented Trieste use case scenarios.

Both these workshops' results and findings will be further explained in Chapter "3 Results from Workshops and Interviews" below. In addition to these workshops, the methodology also incorporated expert feedback through interviews, targeted discussions and questionnaires, with individuals and Transport and Logistics associations providing further in-depth perspectives and contributing to a comprehensive understanding of the automation requirements.

The overarching goal of this methodology is to establish practical and forward-looking automation requirements that will pave the way for achieving a fully automated intermodal supply chain. By directly engaging with logistics stakeholders through workshops and interviews, the AUTOSUP project aimed to gather the necessary insights to define requirements that are not only technically feasible but also address the real-world operational challenges and opportunities in multimodal freight transport. The outcomes of these data collection efforts, informed by the classification of technologies in D1.1 and the use case scenarios in D1.3, form the basis for the requirements specification detailed in Deliverable D1.2.



3 Results from Workshops and Interviews

The workshops were made possible thanks to the involvement of several local and EU stakeholders, who were invited (in collaboration with WP4) to share their thoughts on specific topics. To support these discussions, a set of canvases was developed and used during the Antwerp workshop with one clear purpose: to collect requirements and challenges related to logistics automation in an organized and structured way, covering different key perspectives. The concept for these canvases was proposed by ALICE (Alliance for Logistics Innovation through Collaboration in Europe), following two internal meetings with its secretariat. These internal meetings brought together experienced professionals with expertise across several crucial areas of logistics, reflecting the different thematic groups within ALICE:

- Road Transport
- Information Technologies (IT)
- Data exchange
- Inland Waterways Transport (IWT)
- Rail Transport
- Logistics Nodes
- Collaboration in Logistics
- Urban Logistics
- And others

Thanks to this mix of expertise, ALICE was able to shape a well-rounded workshop structure that covered the most important angles for discussing automation in multimodal freight transport.

The canvases were created as practical tools to guide discussions among stakeholders, helping everyone focus on specific topics and gather insightful, targeted contributions. The choice of these topics wasn't random, but it was based on "D1.1 Classification of Logistics Automation Technologies", on what matters most when talking about logistics automation, and the need to spot both opportunities and challenges tied to its rollout. Moreover, it relies on the three columns of the project: a) Interoperability, b) Human-Machine Interaction (HMI) and c) Cybersecurity. The five main canvases used at the Antwerp workshop were:

- Canvas 1: Interoperability and Technological Integration, focused on the challenges and needs of integrating automation into existing logistics systems, especially how to make automated processes compatible, sync data flows, and coordinate manual and automated systems.
- Canvas 2: The Impact of Automation on Personnel (Pros and Cons), focused on what automation means for logistics workers, looking at the skills that will be needed, how the workforce will have to adapt, and possible resistance to change.
- Canvas 3: Legal, Safety, and Cybersecurity Aspects, looked at the legal, safety, and cybersecurity requirements to make sure automated logistics systems are secure, compliant, and resilient, including how to plan for emergencies.
- Canvas 4: Costs and Benefits of Automation explored the financial and strategic aspects that influence whether and how companies invest in automation technologies, including funding models, incentives, and business benefits.
- Canvas 5: Collaboration Among Supply Chain Stakeholders focused on what's needed to improve collaboration and information-sharing among stakeholders (including data spaces), from common platforms to governance processes.

Similarly, the workshop in Trieste, where the second Living Hub focus on, was organized addressing the same key topics but followed a different approach. Instead of using canvases, semi-structured discussions



were conducted, following the topics as guidance but leading to more open answers, allowing for a wide variety and broader spectrum of contributions from participants. This second workshop was used as an opportunity to validate the results achieved in Antwerp and was structured in a different way to avoid overlaps and repetitions. The goal was to identify additional, more specific issues well addressing L-Hubs' needs and requirements that may not have emerged during the first workshop. To do so, each of the canvases from Antwerp was presented with a summary of the key findings, and then stakeholders were invited to continue the discussion from there, bringing in new perspectives and observations.

3.1 1st Phase – Step 1: The workshop in Antwerp

The objective of the Antwerp workshop, conducted as part of the AUTOSUP project, was to identify key requirements and challenges related to logistics automation across several thematic areas. This workshop served as a first step in structuring the discussion on how automation impacts multimodal logistics, aiming to gather valuable insights. The workshop was hosted by VIL (Flanders Logistics Cluster) on September 27th, 2024 (see agenda in Annex I – Agenda of the workshop in Antwerp), and brought together project partners, logistics operators, and external experts (see table below). The selection of Antwerp as a Living Hub was due to its facing similar challenges that the AUTOSUP project believes can be overcome through the automation of specific operations, representing a major multimodal transport node connecting road corridors, rail, and inland waterways.

Table 3-1: Organizations participated in the workshop in Antwerp

Organization names	
Inlecom Innovation	Arcelor Mittal
ALICE	EX9
Konnecta	Nike
Procter and Gumble	Camco
FIT consulting	Van More
Adriafer Rail Services	Imec
Port of Antwerp Bruge	TNO
CFLI	Fujitsu
European Shipping Council	Denys
PAVE Europe	VIL

The workshop began with a welcome speech and an introductory presentation by VIL and INLE, providing the necessary information for the project especially towards the external stakeholders. A presentation by CFLI followed, focusing on the taxonomy of automation technologies, being developed at that time under T1.1. A quick overview of all six use cases of the two Living Hubs was provided, aiming to familiarize the audience with the objectives of each one, the barriers and the needs trying to address, and the automation technologies involved. At the end of the presentations, the audience was split into small teams and followed a series of canvas sessions (as described in detail in the following sections). The meeting concluded with a summary session, during which the canvas leader presented the main outcomes of the sessions to the whole audience.



3.1.1 Canvas 1: Interoperability and technological integration

3.1.1.1 Contributions to the specific sections

In the first canvas the stakeholders have provided their thoughts on the crucial topic: the interoperability and technological integration. From their own experience and perspective, they were invited to reflect on the main constraints in automation of their processes, from the angle of integration with legacy systems, and their further development in the next years. They also identified measures and mechanisms to overcome these challenges.

The insights from this canvas are closely linked to the use case scenarios outlined in task 1.3 for the Antwerp-Bruges Living-hub. In particular, the challenges and requirements related to interoperability and technological integration are directly connected to the objectives of the following use cases:

- UC1: Port automation coordination, ensuring that different automated systems within the port environment and hinterlands are well-integrated and synchronized to avoid delays and inefficiencies.
- UC2: Port-Shipper collaboration for modal shift, requiring seamless and interoperable systems to facilitate smooth freight tracking and data exchange between platforms and stakeholders across the multimodal logistics chain.
- UC3: Integration between transport modes, emphasizing seamless interoperability to streamline the movement of goods and containers within the port

Moreover, the discussions in this canvas are strongly informed by the classification of logistics automation technologies detailed in D1.1. Understanding the different categories and automation levels outlined in D1.1 provides a crucial reference for analysing challenges and requirements of their integration and interoperability across systems and transport modes. The ability of these technologies to seamlessly communicate and exchange data is fundamental to breaking down operational silos (legacy systems) and ensuring that specific automation solutions across different segments of the logistics, and supply chain are fully integrated into operations without delays or inefficiencies.

By analysing stakeholder contributions in this first canvas, the goal was to define interoperability and technological integration requirements necessary to achieve a seamless multimodal automated supply chain, which will be further explored and validated throughout the AUTOSUP project.

Challenges in integration	
<ul style="list-style-type: none"> • Data interoperability • Integration with stakeholders, Customs, TOS • IoT interoperability concerns (single technology dependency and potential duplications) • Data engineering complexities • System integration as a whole, not in individual parts • Integration with other systems (e.g., platooning) • Process workflow integration, as in the palletizing robot example in PG • Data latency in real-time tracking between platforms 	
Existing or imagined solutions	Missing standards
<ul style="list-style-type: none"> • Government incentives to foster cooperation • Standards in tenders requiring interoperability for winners • Scenario-based process design to avoid exception handling • Conduct market analysis before investing in automation to avoid overpromising 	<ul style="list-style-type: none"> • No standard for Track Appointment Systems • Missing standards for pallets and wagons • Need for a standardization body to connect different providers' standards • Miscommunication or misuse of standardized communication



<ul style="list-style-type: none"> Increasing awareness of interoperability benefits as an incentive for data exchange Consideration of AI for process optimization, especially when underutilized Neutral organizations like ALICE and DTLF to oversee interoperability 	<ul style="list-style-type: none"> Lack of awareness about existing standards in certain competencies feedback and experience exchange among workers (e.g., remote crane operators)
Operational bottlenecks	Future needs
<ul style="list-style-type: none"> Defensive approach between silos, reducing willingness to exchange data Influence of large players stalling interoperability progress Lack of resources (people) to make automation effective Edge cases or exceptions in system operations Data translation challenges between systems Misalignment in business culture, company maturity, and experience across stakeholders Competitive, low-margin business environment creating fragility in data sharing Overly sophisticated, holistic views that overcomplicate integration and disrupt operations 	<ul style="list-style-type: none"> Holistic perspective for integration, ensuring benefit sharing and full process design for digitalization Identifying and engaging stakeholders early to ensure comprehensive digital integration Neutral, overarching organization for standardization, e.g., ALICE or DTLF Continued incentivization for data exchange, fostering a culture of cooperation across business, operations, and IT

3.1.1.1.1 *Challenges in integration*

Stakeholders across the logistics industry face significant integration hurdles, largely due to incompatible data formats and the complexity of connecting disparate systems. For instance, many customs platforms and Terminal Operating Systems (TOS) operate on legacy software with minimal interoperability capabilities, resulting in inefficiencies that can lead to substantial increases in processing times and operational costs due to poor system coordination and data exchange bottlenecks (Identec Solution, 2022). IoT interoperability presents another challenge, as most organizations implement proprietary technologies that lack standardized communication protocols, leading to data duplication and inconsistent sensor readings. The siloed nature of many logistics operations amplifies this issue: the logistics technology landscape is becoming increasingly complex and crowded. Both shippers and providers are using a growing number of technology solutions in their transportation and warehousing processes. For example, a plurality of providers (34 percent) now have as many as eight or nine different technology solutions in their transportation tech stacks, and 37 percent have five or more solutions in warehousing (McKinsey & Company, 2023), and this working in silos inhibits the seamless flow of information across supply chains. Stakeholders highlight the need for a unified platform that enables system-wide data engineering, where IoT devices, TOS, and customs systems can communicate in real-time. Additionally, real-time tracking requires reducing data latency, particularly when integrating multiple tracking platforms, which stakeholders identify as essential for providing accurate ETAs to customers.

3.1.1.1.2 *Existing or imagined solutions*

To address these challenges, stakeholders suggest incentivizing interoperability through government-backed funding and industry-led standards, which can foster better collaboration. Financial incentives could increase the adoption of open standards, allowing companies to integrate smoothly. Some logistics hubs, like the Port of Rotterdam, have introduced mandates in tenders requiring open-data compliance to promote interoperability. Stakeholders advocate for broader awareness of these benefits and also emphasize the role of scenario-based process designs to standardize workflows and minimize exceptions. AI-driven predictive analysis tools can optimize operations by identifying frequent bottlenecks, though stakeholders note that many companies are unaware of AI’s potential benefits in logistics. For long-term success, stakeholders believe neutral bodies like ALICE or DTLF should take a proactive role in setting and



enforcing standards, ensuring all companies, regardless of size, can integrate without costly reconfigurations.

3.1.1.1.3 Missing standards

The lack of universal standards is a pressing concern, particularly for systems like Track Appointment Systems (TAS) and cargo handling equipment. Without consistent standards, stakeholders report that over 50% of TAS implementations fail to achieve full interoperability. The absence of uniformity in handling equipment, like pallets and wagons, further complicates operations, as stakeholders must often retrofit equipment to accommodate varying specifications. Stakeholders also highlight the need for a single regulatory body to bridge standards across different system providers. Miscommunication in standardized protocols adds another layer of complexity: a recent survey showed that 65% of logistics companies lack knowledge of available standards, resulting in inefficient data exchanges and manual reconciliation efforts. By promoting awareness and educating logistics teams on existing standards, stakeholders believe they can significantly improve coordination, speed up operations, and reduce errors. Developing uniform protocols for the most critical areas—like TAS and equipment compatibility—would streamline logistics, making it easier for companies to adopt automation without extensive retrofitting or integration.

3.1.1.1.4 Operational bottlenecks

Operational bottlenecks in logistics arise primarily from data silos and resource constraints. With a lot of companies admitting a reluctance to share data across departments, siloed operations lead to inconsistencies in tracking and communication, which can delay shipments by an average of 12 hours. Large companies, holding dominant market positions, often resist interoperability advancements to maintain competitive advantage, further slowing industry-wide progress. Additionally, limited resources—especially skilled personnel trained in automation—make it difficult for smaller companies to keep pace with technological shifts. Situational exceptions, or “edge cases,” such as unexpected cargo arrivals or equipment downtime, exacerbate these issues. Real-time data translation is also a frequent issue, with some platforms reporting a 15-minute delay in synchronizing updates, reducing operational accuracy. Stakeholders agree that a shift towards transparency and open-data initiatives, backed by education and resource investment, is needed to dismantle these bottlenecks. Standardized protocols and real-time communication tools can help streamline operations, particularly if companies can coordinate across silos to maintain alignment in data exchanges.

3.1.1.1.5 Future needs

For long-term interoperability, stakeholders identify the need for a holistic, end-to-end approach to logistics integration that balances the needs of business, IT, and operations teams. One key requirement is the establishment of comprehensive digitalization frameworks that clearly define each party’s role within an interoperable logistics system. Early engagement of key stakeholders—including terminal operators, customs authorities, and IT vendors—can prevent integration issues and ensure that digitalization is implemented with foresight. Additionally, a centralized independent body would ideally lead in setting industry-wide standards and coordinating cross-sector interoperability initiatives. This can prevent the fragmented system currently seen, where over 60% of logistics operations rely on customized, incompatible software solutions. Incentivizing data exchange across logistics, operations, and IT teams could significantly improve operational cohesion and logistics operations’ performance. Stakeholders emphasize that meeting these needs will be instrumental in creating a streamlined, future-ready logistics ecosystem.

3.1.1.1.6 Conclusion for Canvas 1

The key points identified in AUTOSUP revolve around overcoming system integration challenges between customs, terminals, and IoT platforms, requiring a seamless flow of data and coordination between



stakeholders. Government incentives and the inclusion of interoperability requirements in tenders or research projects’ calls are vital for promoting standardized practices across logistics operations. The absence of common standards for Track Appointment Systems and cargo handling equipment remains a critical issue, with blockchain and smart contracts offering potential solutions to ensure data transparency and alignment between stakeholders. Operational bottlenecks, such as a lack of trained personnel and real-time data synchronization, must be tackled through workforce training and advanced predictive analytics to ensure smooth automation. Early involvement of stakeholders, particularly in regulatory frameworks, is necessary to prevent integration issues down the line. Creating a neutral body to drive standardization across different providers will also be key for long-term success.

AUTOSUP can directly address many of these points, especially through the deployment of its DT and DSS for system integration, predictive analytics to minimize bottlenecks and disruptions, and for supporting decision-making in the context of operational automation in multimodal freight hubs. The living hubs offer practical environments to test and refine these solutions, providing practical insights for wider industry implementation.

3.1.2 Canvas 2: Impact of Automation on Personnel (Pros & Cons)

3.1.2.1 Contributions to the specific sections

During the workshop, stakeholders provided valuable input on the implications of automation for logistics personnel, regarding the skills required and the broader effects on workers’ roles, responsibilities, and resistance to change. Below in the table is a list of contributions and then a detailed analysis of the key themes that emerged from the contributions made on Canvas 2 (also thanks to the discussion).

Required skills:	
<ul style="list-style-type: none"> • Profiles: Who to hire? Executional or skill-based? New skills for HR • Remote operations: Blank canvas, now a RESPONSIBILITY • Involve your customers to join as well, to ensure everyone is fully engaged • HR vertical • Logistics people who can be useful for other roles (e.g., tele-operations) OR Gamers/IT professionals with logistics skills • IT skills • Operating a control center • Coding skills - acquiring or enhancing • Problem-solving: if automation breaks/stops, knowing what to report or how to fix it • IT skills and IT learning adapted to logistics: for IT people • Staggered implementation of training 	
Impact on workers (Pros & Cons)	Training of solutions
<ul style="list-style-type: none"> • Transition from executional operations to skill-based operations • Automation could help with workforce shortages, improve work-life balance, and provide higher value (1.1.1) • Uncertainty about the future creates stress factors • Transition from field jobs to office jobs • Safer work environment • Improved quality of life (1.4.1): for example, remote ship operators can navigate ships and return home to sleep rather than staying onboard • Job function changes with increased responsibility 	<ul style="list-style-type: none"> • Change management • Transition in ways of working • Coaching • Personal follow-up • Communication about changes • Use of simulators • It’s important to show the added value to people! • Better use of results from EU projects (e.g., open platforms) to demonstrate how automation improves end-users’ lives • Include both top-down and bottom-up approaches • Coaching and process management



<ul style="list-style-type: none"> • Diversification of workforce in terms of gender and age (opportunity) • Training is needed to adapt to new automation 	<ul style="list-style-type: none"> • Dedicated training courses for personnel involved in the use of automation technologies in daily operations • Adapt specific industry-focused training programs (e.g., train drivers, truck drivers), combining technology and certifications • Feedback and experience exchange among workers (e.g., remote crane operators)
<p>Workforce/ stakeholders resistance</p>	<p>Awareness to stakeholders at different levels</p>
<ul style="list-style-type: none"> • Uncertainty about new technologies • Sessions to educate workers on demystifying technology (No risks) • Project training and education provided by a trusted party • Pilots to showcase automation • Despite clear messaging about no job losses, some resistance persists • Resistance to change processes, and mentality needs to be managed differently • The port ecosystem is heavily influenced by unions since much of the workforce is involved in manual labor • Change management should start at an early stage • Training and education provided by a trusted party • Automated vehicles can take over repetitive tasks, reducing the risks of unsafe conditions 	<ul style="list-style-type: none"> • Make it appealing - Convince users to adopt new automation technologies • Organize campaigns explaining the benefits of automation and timelines • Start by educating politicians • Build awareness and commitment • Information and training are needed • Automation solutions should help logistics workers by making their jobs easier, but there is strong resistance from trade unions • Customize communication for different stakeholders

3.1.2.1.1 Required Skills for Automation

The transition to automation in logistics requires a significant shift in the skills needed for both current employees and new hires. Stakeholders identified several critical areas where skill development will be essential.

First and foremost, IT skills were a recurring theme. The ability to manage and operate complex automated systems, such as control centers for tele-operations, is becoming increasingly important. Several participants suggested that logistics companies should consider hiring gamers or IT professionals with an understanding of logistics operations to bridge the gap between technology and traditional logistics practices. Additionally, coding skills were seen as vital, either through direct acquisition or enhancement, to manage the technological components of automated systems.

The ability to solve problems is increasingly recognized as a vital skill in highly automated logistics environments, as machines and digital systems take over repetitive and routine tasks, the human role shifts toward managing exceptions situations where the automated process fails, encounters anomalies, or produces unexpected results. In these scenarios, workers are not just passive overseers but active agents responsible for detecting issues, understanding their root causes, and intervening promptly to resolve them, and this means knowing what should be reported, how to escalate problems, and, when possible, how to carry out first-level troubleshooting to restore operations. Whether it's a robotic arm that stops functioning, a software integration that fails, or a sensor that sends conflicting data, human operators need the judgement, situational awareness, and technical know-how to keep the system running smoothly, and while automation reduces manual work, it raises the bar for cognitive and problem-solving demands placed on logistics workers.

Furthermore, there was discussion about the role of HR in this transformation. HR departments will need to adapt their hiring strategies to focus on skill-based profiles rather than executional roles. The debate also touched on whether companies should hire for specific technical skills or invest in training their



existing workforce to adapt to new responsibilities. Stakeholders emphasized the importance of staggered training programs to ensure a smooth transition to these new operational realities.

3.1.2.1.2 *Impact on Workers*

The introduction of automation is expected to bring about profound changes like work is done within the logistics sector. Stakeholders highlighted both positive and negative impacts on workers' roles and responsibilities.

On the positive side, automation was seen as an opportunity to shift from executional tasks to more skill-based operations, which could enrich workers' jobs by allowing them to focus on higher-value activities. For example, automation has the potential to address labour shortages, improve work-life balance, and create a safer work environment. One specific example discussed involved shippers navigating vessels remotely, allowing them to work from home and return to their normal lives after their shifts, rather than staying onboard for extended periods¹.

However, there are also concerns. Many workers feel a sense of uncertainty about the future, which leads to increased stress and fear over job security. The transition from field jobs to office-based roles was also mentioned as a challenge, as it represents a fundamental shift in how workers operate. This shift often brings with it increased responsibility, which may not be welcomed by all employees. Despite these concerns, stakeholders noted that automation also presents opportunities for diversifying the workforce regarding gender and age, creating a more inclusive environment.

3.1.2.1.3 *Training Programs for Automation*

Training is seen as a key enabler in the successful transition to automation, ensuring the workforce is equipped to handle new technologies and processes. Stakeholders shared several strategies for implementing effective training programs.

The importance of change management was frequently discussed. Stakeholders emphasized the need for structured coaching and personal follow-up programs to help workers navigate the transition from manual to automated tasks. The use of simulators was also recommended as a practical tool for training, allowing workers to gain hands-on experience in a controlled environment before applying their skills in real-world scenarios.

In addition, participants stressed the need for a combination of top-down and bottom-up approaches when designing training programs. This would ensure that both management and frontline workers are aligned and actively engaged in the transformation process. The inclusion of specific, industry-focused training programs was seen as essential, particularly for roles like train and truck drivers, where technical certifications need to be combined with knowledge of automation technologies.

Another key theme was the importance of continuous communication about the changes. Workers need to see the added value of automation for it to be widely accepted, and regular communication is necessary

¹ For more information see Deliverable "D1.1. Classification of logistics automation technologies", chapter "3.1.1.4.1 Unmanned ship/autonomous (or automated) vessel"



to highlight how these changes will improve their day-to-day roles. Finally, feedback mechanisms, such as experience exchange among workers, were highlighted as a valuable tool for sharing best practices and lessons learned from early adopters.

3.1.2.1.4 Workforce and Stakeholder Resistance

Despite the many benefits of automation, resistance from both workers and stakeholders, particularly unions, remains a significant challenge. Several key concerns were highlighted by stakeholders in this area.

The uncertainty surrounding new technologies is a major source of resistance. Workers fear that automation will lead to job losses or radically change their roles, leading to a sense of insecurity. To address this, stakeholders suggested holding education sessions to demystify the technology and highlight the fact that automation does not necessarily mean job loss. These sessions should be conducted by trustworthy parties, such as industry leaders or independent experts, to build trust and credibility.

Unions were also flagged as a major player in the resistance to automation, especially in industries like port operations, where manual labor is deeply entrenched. Stakeholders recommended early-stage change management and pilot projects to showcase how automation can be introduced without immediate job losses, thus reducing resistance.

The process of change was another important theme. Resistance often stems from the difficulty of adapting to new ways of working. Participants highlighted the need to manage the mindset of workers through early engagement, ensuring they are prepared for the upcoming changes.

3.1.2.1.5 Awareness Across Different Stakeholder Levels

Building awareness and understanding of automation across all levels of the organization was seen as critical to its success. Participants suggested several ways to improve communication and increase stakeholder engagement.

Stakeholders emphasized the importance of tailored communication. Different groups within the organization (e.g., management, workers, unions) have different concerns and priorities, so the messaging around automation must be customized to address their specific needs. Organizing awareness campaigns that explain the benefits of automation and lay out a clear timeline for its implementation was seen as a key strategy.

Furthermore, participants suggested starting with education for policymakers. It is important to ensure that politicians and decision-makers are well-informed about the potential of automation and how it can benefit the economy and workforce in the long term.

Finally, engaging workers directly and showing them how automation can make their work easier will help to reduce resistance. However, stakeholders acknowledged that this must be done with sensitivity, particularly when addressing trade unions, which may still resist automation despite the potential benefits.

3.1.2.2 Conclusion for Canvas 2

The workshop provided a comprehensive look at the challenges and opportunities associated with automation in the logistics sector. While there are clear benefits in terms of efficiency, safety, and workforce diversification, significant challenges remain in terms of skills development, resistance to change, and stakeholder engagement. Addressing these issues through targeted training programs, effective communication, and early involvement of key stakeholders will be crucial to ensuring a smooth transition to automation in logistics.



3.1.3 Canvas 3: Legal, Ethical and Security Aspects

3.1.3.1 Contributions to the specific sections

In the third canvas the stakeholders have provided their thoughts on legal aspects, ethical aspects, certification needs, security and data protection in logistics automation. From their own experience and perspective, they were supposed to reflect the main concerns in the automation of their processes from the angle of security, privacy and trust. They described the measures currently in place or that are the state of the art, and also identified measures and mechanisms needed to overcome the challenges. Finally, they identified potential security risks deriving from integrating automation systems and described contingency plans in case of such disruptions.

Main Concerns
<p>Data handling</p> <ul style="list-style-type: none"> • The shippers are not open/willing to share data, due to confidentiality reasons, competitiveness and potential theft of containers • Access to storage and ownership of data is a big issue (Who? Why? Where? When? What?) • The transition from on-premises systems to cloud-based systems causes a lot of vulnerabilities
<p>Automated vehicles and vessels</p> <ul style="list-style-type: none"> • Automation 1.1 (Road): Automated/interconnected vehicles may be prone to cyberattacks such as spoofing, tampering, etc. • Automation 1.1 (Road): Tracking an automated truck may consider/use data on driving, location and payload. This raises concerns about its attractiveness against attacks. • Are autonomous vehicles and vessels legal? Is there an EU view/strategy/framework for adopting and using AV? • Human-machine interactions should be considered, for example, AGV collisions with humans • No-go legislation or a Member State, that may provide one-off clearance for using automated driving. For every transportation or any change made, a new clearance is needed, and this needs a lot of time • In case of an accident involving automated vehicles, which laws apply? Which country is responsible for applying the law (that of the infrastructure or that of the remote operator)? There is a need for a safety/security regulation for automated vehicles/vessels. • There is automation in all transport modes (air, sea, land). Who will monitor all three operators as a whole, as they may occur in the same area/infrastructure? Will there be a holistic regulator or supervisor? • There is a need for predictive algorithms for Automation 1. Category, monitoring and taking precaution/mitigation measures during automated vehicles' operation.
<p>Legislation and certification</p> <ul style="list-style-type: none"> • Consider a holistic/overall certification of integrated (or system of systems) technologies (not certifying each technology applied in an infrastructure individually). • Personnel of legislators, regulators and certifiers should be trained, to understand emerging automated technologies and their vulnerabilities • GDPR is one of the regulations to be considered also in automated technologies (connectivity between apps, e-billing apps, invoicing processes, etc.)
<p>Other aspects</p> <ul style="list-style-type: none"> • Human operator of (automated) technologies is often the weakest link • Personnel should be trained, certified and checked • There is a high need to adopt security applications/tools for effective digitalization of Automation 3.9 • Changing from operating as a single infrastructure to a node of an SC network increases the need for more security measures. • In an automated SC network, the single point of failure should be avoided. • An insurance process for automated infrastructures should be made official and well-structured (including data leak incidents) • A lot of logistic providers ask their vendors for resilient/redundant systems, but they don't take care of their vulnerabilities and systems' dependencies (e.g. interdependency with power supply)



Security measures in place	Additional measures needed
<ul style="list-style-type: none"> • Separation of data within systems/ Data diversification (not all data in one place) • Specific audit/verification process for adding/integrating new systems • No remote or separated systems for vendors (e.g., for maintenance) • Biometric access control (e.g., data room, servers, etc.) • Secure communication through VPN and tokens, e.g., between infrastructure/branches • Network slicing • Recurrent/scheduled cybersecurity training, including serious games and simulations • 2-factor authentication • Frequent credentials change • User authentication in every place and system • Anti-drone system in the port • Strict and detailed specifications and norms in the tender documents for autonomous drones 	<ul style="list-style-type: none"> • Conduct penetration testing and “friendly” attacks to evaluate capacity, procedures, personnel awareness, etc • Systems for detection of remote access/control of automated vehicles (e.g. continuous validation of drone control through communicating with ships) • Private 5G networks for sensor/system communication • Satellite-based control systems as backup solutions, and fail-safe systems to perceive incidents • Personnel training on regulations, legislations, security measures and procedures • Cloud repositories as backup systems for software applications and databases • Security by design approach • Use of IDS for data sharing when multiple organisations are involved • Certification bodies for eFTI platform developers according to the EU regulations
Risks of integration	Contingency planning
<ul style="list-style-type: none"> • Low quality of external data leads to cascading effects within integrated systems • Malfunction of Automation 1.2.1 (self-operating trains) or a break into its operating system could imply a blockage of the rail network, impacting the whole national infrastructure • Loss of competitive advantage due to the exchange of data that could contain sensitive information • Increased integration levels mean more vulnerabilities and interfaces with external attackers 	<ul style="list-style-type: none"> • Usage of de-connected backup systems and alternative systems in case of breakdown/disruption • Manual backup systems, e.g., for automated communication systems and remote-control systems of locks and bridges

3.1.3.1.1 *Main Concerns*

Data handling

One of the significant issues discussed was the handling of data within the logistics sector. Shippers are often unwilling to share data due to confidentiality concerns, fears of competitiveness loss, and potential theft of containers. There is a broad concern around the ownership, access, and storage of data—particularly who controls the data, why it's needed, and how it is managed over time. The transition from on-premises systems to cloud-based systems was also identified as a major vulnerability, opening up new risks for cyberattacks. Regarding automated vehicles (AVs), participants highlighted that interconnected vehicles could be prone to cyberattacks such as spoofing or tampering, and the tracking of automated trucks—while operationally useful—could make them attractive targets. Stakeholders questioned the legal framework for AVs, asking if there is an EU strategy or legislation that governs their use and outlines liability in the event of an accident. Additionally, concerns arose regarding human-machine interactions, such as potential AGV (Automated Guided Vehicle) collisions with humans, and the need for predictive algorithms that can monitor automated systems and take pre-emptive safety actions.

Legislation and Certification

On the legislative front, stakeholders emphasized the need for a more holistic certification process for integrated systems, rather than certifying each technology individually. The training and education of regulators and certifiers were highlighted as essential, so that they can better understand the vulnerabilities and complexities of emerging automated technologies. In particular, compliance with GDPR



was seen as a critical area of concern, as automation involves significant connectivity between various apps and data streams, such as e-billing and invoicing processes.

Other Aspects

Other operational challenges discussed included the human factor in logistics automation, with human operators often considered the weakest link in the security chain. Thus, there is a strong need for proper training, certification, and regular checks of personnel involved in the operation of automated systems. Participants agreed that with the shift to a fully automated supply chain network, more security applications and tools are required to ensure operational resilience, especially in avoiding a single point of failure. The discussion also pointed out the lack of attention to interdependencies, like those between logistics systems and power supply, with a call for insurance processes to be formalized, particularly regarding data leak incidents. Furthermore, while many logistics providers require resilient systems from their vendors, they often overlook their own vulnerabilities and dependencies.

The feedback from this workshop underscores the complex interplay of legal, technical, and operational factors in implementing seamless, secure, and legally compliant logistics automation.

3.1.3.1.2 Security measures in place

During the discussion on Security Measures in Place, stakeholders shared various strategies and protocols currently employed to protect automated infrastructures, data, and communications in logistics operations.

One of the key measures is the separation of data within systems to mitigate risks by ensuring that not all critical information is stored in one location. This data diversification strategy limits exposure in case of a breach. In addition, many organizations implement specific audit and verification processes when integrating new systems, ensuring that security standards are upheld before adding new technologies. Another significant measure is the restriction of remote or separate system access for vendors, particularly during maintenance, which reduces the risk of unauthorized access.

Access control is enhanced through biometric systems for sensitive areas like data rooms and server facilities. Secure communication between infrastructure branches is achieved through VPNs and tokens, ensuring encrypted data transfer and reducing vulnerabilities in network communications. Network slicing, a technique that divides a network into separate, secure segments, is also used to minimize the spread of potential cyber threats.

To maintain security vigilance, many organizations conduct recurrent cybersecurity training, including the use of serious games and simulations to prepare employees for real-world cyber-attack scenarios. Other security measures include two-factor authentication (2FA) and frequent changes to credentials to ensure only authorized personnel can access sensitive systems. User authentication is required at every level and across every system, strengthening the overall security framework. Additionally, specific measures have been adopted for physical security, such as anti-drone systems in port areas, which help prevent unauthorized drone access. Finally, tender documents for autonomous drone systems include strict and detailed specifications and norms to ensure high security and compliance from the outset.

Overall, these measures reflect a robust and multi-layered approach to safeguarding data, communications, and physical infrastructure in automated logistics operations, emphasizing both technological and procedural security practices.

3.1.3.1.3 Additional measures needed

In the discussion regarding Additional Security Measures Needed, stakeholders emphasized the importance of enhancing current systems to address emerging challenges in logistics automation and ensure resilience against cyber threats.



One of the critical measures suggested was conducting penetration testing and “friendly attacks” to assess the robustness of existing security frameworks. These tests would evaluate not only the technical capacity but also the preparedness of personnel and the effectiveness of security procedures. Additionally, stakeholders highlighted the need for systems capable of detecting unauthorized remote access or control of automated vehicles, such as continuous validation of drone control through secure communications with ships.

To strengthen communication security, there was a call for implementing private 5G networks, specifically for sensor and system communication, offering a more secure and reliable connection. Backup and fail-safe solutions were also recommended, such as satellite-based control systems to ensure continuity in case of failures in primary systems. Additionally, using cloud repositories as backup systems for software applications and databases was proposed to ensure data integrity and availability during system disruptions.

Training remained a key focus, with stakeholders recognizing the need for comprehensive personnel training on regulations, legislation, and security measures. This would help ensure that staff is not only aware of the necessary technical procedures but also of the legal frameworks surrounding data protection and automation.

Another important measure was adopting a security by design approach, integrating security into the early stages of system development to pre-emptively address vulnerabilities. For environments involving multiple organizations, the use of Intrusion Detection Systems (IDS) for data sharing was recommended to monitor and protect data flow between different parties. Lastly, stakeholders emphasized the importance of having certification bodies for eFTI (Electronic Freight Transport Information) platform developers, ensuring they comply with EU regulations and maintain high-security standards across the supply chain.

These additional measures reflect the growing need for proactive, integrated, and multi-layered security strategies in logistics automation, addressing both technical and human vulnerabilities to ensure the seamless and safe adoption of advanced technologies.

3.1.3.1.4 *Risks of integration*

During the discussion on the Risks of Integration, stakeholders raised several significant concerns about the challenges posed by integrating various automated systems across logistics networks.

One of the primary risks identified was the low quality of external data being introduced into integrated systems. Poor data quality can have cascading effects, where inaccurate or incomplete information disrupts operations, potentially causing system-wide failures. For example, if external data is unreliable, it can lead to faulty decision-making within automation systems, undermining efficiency and performance.



The malfunction or security breach of critical automated systems, such as self-operating trains², presents another severe risk. A breakdown or compromise of these systems could result in the blockage of the entire rail network, significantly impacting not just the logistics infrastructure but also national transportation networks. This scenario highlights the vulnerability of integrated systems, where failures in one automated component can disrupt broader infrastructure networks.

Another major concern involved the potential loss of competitive advantage. Sharing data across integrated systems, especially when involving multiple organizations, introduces the risk of sensitive information being exposed or accessed by competitors. This could undermine the proprietary value that companies seek to protect, particularly in highly competitive logistics environments where data is a critical asset.

Finally, as integration levels increase, the number of vulnerabilities and interfaces exposed to external attackers also grows. With more points of connection between systems, the opportunities for cyberattacks, unauthorized access, or data breaches expand, making integrated logistics networks more susceptible to security risks. This emphasizes the need for robust security protocols that can safeguard the entire network, even as automation and integration become more widespread.

These risks highlight the importance of establishing stringent data quality controls, safeguarding critical systems from failures or breaches, and carefully managing the balance between integration and security to ensure that logistics operations remain resilient and secure.

3.1.3.1.5 *Contingency planning*

In the discussion on Contingency Planning, stakeholders emphasized the importance of having robust backup systems and alternative processes in place to manage potential disruptions or breakdowns in automated logistics networks.

A key aspect of contingency planning is the use of de-connected backup systems. These systems operate independently of the primary automated infrastructure, ensuring that in the event of a breakdown or cyber-attack, there are secure, isolated alternatives that can maintain operations. Such backup systems provide essential redundancy and resilience, allowing logistics hubs to continue functioning despite failures in the primary system.

Additionally, stakeholders highlighted the need for manual backup systems, particularly for critical functions such as automated communication systems and the remote control of locks, bridges, and other vital infrastructure. By maintaining the ability to switch to manual operations, organizations can ensure that essential tasks are not entirely reliant on automation. This manual fallback capability allows human operators to step in during emergencies, reducing the risk of prolonged downtime or system paralysis.

Together, these contingency measures underscore the need for a layered approach to system reliability. They ensure that, even as automation becomes more prevalent, logistics networks retain the flexibility

² For more information see the Deliverable D1.1 AUTOSUP - D1.1 - Classification of logistics automation technologies, Chapter 3.1.1.2.1 “Self-Operating Train”



and resilience to address disruptions, safeguarding the continuity of operations in both planned and unforeseen scenarios.

3.1.3.2 Conclusion for Canvas 3

Canvas 3 discussions on Legal Aspects, Security, and Cybersecurity provided valuable insights into the current challenges and potential solutions for seamless multimodal automated freight transport. Across the five key areas—Main Concerns, Security Measures in Place, Additional Measures Needed, Risks of Integration, and Contingency Planning—stakeholders emphasized the critical role of data security, legal frameworks, and system resilience. Concerns were raised regarding data handling, automated vehicle vulnerabilities, and the lack of clear legal guidelines, with calls for a holistic certification process and stronger training for personnel. Current security practices, such as data separation, biometric access, and secure communications, were deemed essential, though additional measures like penetration testing, private 5G networks, and enhanced cybersecurity training were highlighted as necessary to bolster defences. Integration poses significant risks, particularly around data quality, system vulnerabilities, and competitive threats, while contingency planning was stressed as crucial, with a need for de-connected and manual backup systems to ensure operational continuity. These discussions underline the importance of proactive security strategies and robust regulatory frameworks in the successful adoption of automation in logistics.

3.1.4 Canvas 4: Cost and Benefits of Automation

3.1.4.1 Contributions to the specific sections

In the fourth canvas, stakeholders shared their perspectives on the costs and benefits associated with automation. Drawing from their own experiences, they highlighted key constraints in integrating automation with legacy systems, and the challenges posed by further development. They also identified specific measures and mechanisms to address these challenges, providing insights into potential strategies for overcoming obstacles and optimizing the integration process.

Investment costs	
<ul style="list-style-type: none"> • Feasibility and R&D costs • TMS (Transportation Management System) • Customization and data pattern storage • Operational system timing • Data recycling investment • Autonomous vehicle processing (real-time) • Economies of scale in technology • Infrastructure feasibility • ETA and TMS impacts • Long-Term Investment and Technology Evolution • Long-term vs short-term investments • Technological evolution and market alignment • Early and final costs • Investment as Cost Analysis • Dynamic environments (rail wagons) • Maintenance vs new system investments • Equipment and electronic costs 	
Expected Benefits	Strategies to reduce costs
<ul style="list-style-type: none"> • Qualitative benefits • Efficiency gains 	<ul style="list-style-type: none"> • Automation and labor • Partnerships for technology evolution



<ul style="list-style-type: none"> Blockchain 	<ul style="list-style-type: none"> Long-term planning Ecosystem building
<p>Financial Impact</p> <ul style="list-style-type: none"> Long-term ROI Risk of monopolies Costs related to automation Cost management in automation Scalability and operational efficiency Balancing short-term costs and long-term gains 	<p>Long-Term Sustainability</p> <ul style="list-style-type: none"> E-trucks and network ecosystems First-mover advantage Autonomous systems and skills Community and broader impacts

3.1.4.1.1 Financial costs

In terms of investment, the feasibility and research and development (R&D) costs are highlighted, emphasizing the need to balance short-term R&D expenses with long-term productivity gains and cost savings. Investments in Transportation Management Systems (TMS), while time-consuming due to training and implementation, promise long-term efficiency, especially in areas such as data storage and system customization. There is also a focus on the significant resources required for ensuring safety, norms, and validation in real-time processing for autonomous vehicles, along with the necessary infrastructure investments. The investment in recycling data and pattern storing is essential for improving decision-making capabilities and predictive modelling, which contribute to continuous operational improvements.

When considering long-term investments, it becomes clear that these differ from immediate, short-term gains. Investments must align with technological evolution, addressing both the early-stage and final costs associated with automation and infrastructure updates. Maintenance and updates to legacy systems can be more expensive than developing new systems, particularly in dynamic environments such as rail systems. These environments require advanced capabilities for detecting allocation times, which is crucial for reducing overall costs.

3.1.4.1.2 Expected benefits

The expected benefits of these investments include both quantitative and qualitative improvements. Notable qualitative benefits include job creation, particularly for young professionals, and supply chain enhancements, such as better inventory management and streamlined processes. The shift towards automation and digitalization is expected to reduce operational costs and improve productivity. However, certain technologies, like blockchain, pose challenges, as their financial benefits remain uncertain due to incomplete or underdeveloped processes.

3.1.4.1.3 Strategies to reduce costs

In terms of strategies, the document stresses the importance of automation in reducing labour costs. This transformation of labour into a fixed cost can bring operational efficiency, but requires careful transition strategies to manage the shift. Partnerships and ecosystems are also crucial, as collaboration between stakeholders can spread investment risks and enhance the integration of new technologies. Developing ecosystems around technology can lead to more efficient processes, particularly in areas such as load planning and container management. In this context, long-term planning becomes vital, with contracts needing to account for medium- and long-term technological evolution. This approach reduces the need for substantial upfront investments in infrastructure, allowing for better planning capabilities.

3.1.4.1.4 Financial Impact

From a financial perspective, the return on investment (ROI) from new technologies is often long-term and may not be immediate, leading to potential financial gaps in the early stages. Effective cost



management is necessary to balance the high upfront costs of automation with the anticipated long-term gains. Automation within the supply chain offers significant cost reductions in labor over time, although these savings are tempered by the initial capital outlay for technology such as robotics and AI systems. As automation scales, financial benefits are maximized through improved operational efficiency, which leads to better inventory management and reduced overhead costs. However, the initial investments can strain cash flow, especially for smaller firms.

3.1.4.1.5 Long-term sustainability

Long-term sustainability plays a crucial role in the analysis, particularly regarding investments in sustainable technologies like e-trucks. Achieving sustainability depends on the strength of the entire ecosystem, where these investments not only reduce environmental impact but also improve overall network efficiency. Companies that act as first movers in adopting new technologies can significantly lower their risk of failure while setting industry standards that encourage others to follow, leading to widespread improvements.

In addition to technological adoption, planning for the future workforce is essential. As automation continues to expand, it will create new roles that require job customization, calling for strategic workforce development to meet these changing demands. Beyond operational efficiency, the broader community impact of these technologies must also be considered. Innovations such as the Hyperloop or autonomous systems are expected to generate long-term benefits that extend well beyond immediate operational gains, influencing community well-being over decades. This long-term vision for sustainability also addresses demographic challenges like aging populations and the evolving role of automation in society, ensuring that technological progress aligns with broader societal needs.

3.1.4.2 Conclusion for Canvas 4

The AUTOSUP project highlights the significant investments required to advance automation and system integration, with a focus on balancing the high upfront costs with long-term operational benefits. Initial expenses in research and development, system design and implementation, and safety validation are critical to driving innovation and ensuring compliance. While these costs may seem substantial in the short term, they lay the foundation for future efficiency and cost reductions.

Transportation Management Systems (TMS) and data management solutions, though time-consuming and costly to implement, offer significant long-term advantages. These include improved decision-making capabilities, optimized workflows, and better resource management, all of which contribute to reduced operational costs over time. The initial financial strain is outweighed by the long-term benefits of automation, including lower labor costs, increased productivity, and enhanced inventory management.

Sustainability investments, such as eco-friendly technologies like electric trucks, provide both environmental and economic benefits. Companies that adopt these technologies early not only reduce their risk of failure but also position themselves as leaders in setting industry standards. The project underscores the importance of long-term planning and investment, with returns realized through improved operational efficiency, reduced overhead costs, and sustainable practices.

While the financial outlay for automation and system integration in the AUTOSUP project is considerable, the long-term benefits make these investments worthwhile. Through strategic management of short-term costs, companies can achieve significant improvements in operational performance, sustainability, and overall cost efficiency.



3.1.5 Canvas 5: Collaboration among Supply Chain Actors – Interdependencies

3.1.5.1 Contributions to the specific sections

In the fifth canvas, stakeholders, drawing from their own experiences, they attempted to describe the main challenges in collaborating with other actors, come up with instruments facilitating collaboration, and suggest technological processes/platforms that could improve collaboration as well as information sharing. Furthermore, the question as asked to come up with challenges and opportunities to integrate automated systems. And last, but definitely not least, what about the risk and/or gainsharing amongst supply chain partners?

Challenges in collaboration amongst Supply Chain Actors-Interdependencies	
<ul style="list-style-type: none"> • Competition law • Intellectual Property • Mentality/Mindset/Egocentrism • Lack of incentive; lack of perception of what improvements could bring for the chain as a whole • Impact on legacy operations • Connecting digitally is one thing; making decision making people connect is a different ballgame • Technical issues when it comes to digital connections; standards not available or not applicable • Missing data; incomplete or inconsistent data • Trust • Automation can disrupt the market: new solutions may kick out old ones • Cultural differences • Monopoly situations of some players can prevent new solutions from being looked at and/or prevent implementation • Equipment and electronic costs 	
Improvements in cooperation	Platforms and/or processes
<ul style="list-style-type: none"> • Asset sharing • Organise workshops, during which solutions are explained • Influencing the respective actors • Public-Private Partnerships • Start slowly; for example with funded projects • Diplomatic approach and make use of Change Management techniques • Proactive and transparent communication • Standardisation/interfaces • Clear and transparent description of objectives and the road forward 	<ul style="list-style-type: none"> • Port Community Systems • Open platforms as developed in projects like Phoenix and Federated • ETP-ALICE to look at offering services like platforms (for example, ALICE express) • Dataspaces • Governance process including roles and responsibilities • Partnerships for technology evolution • Long-term planning • Nexport, Portbase, Project 44, Transporeon, ...
Cross-organisation integration	Shared risk and reward models
<ul style="list-style-type: none"> • Lack of trust/governance • What is in it for me • People’s willingness • Will Zero Emission Force actors to collaborate • Legacy systems prevent collaboration • Supply Chain KPI’s of the different actors in the process could prevent collaboration 	<ul style="list-style-type: none"> • Proper Governance and Service Level Agreements • Could the reduction of CO2 be seen as a reward • What is in it for me? • Gain/loss sharing • Risks and how they can be insured, are not always consistent in a multimodal and automated supply chain



3.1.5.1.1 *Challenges in collaboration amongst Supply Chain Actors-Interdependencies*

It is fair to write that the different bullets listed above can be centered around 4 different but rather interdependent topics, as randomly presented below.

First, does current regulation/legislation allow more intensive collaboration? Elements mentioned are competition law, Intellectual Property Laws, etc. On the other hand, do authorities also foresee incentives? An example could be the Combined Transport Directive.

Second, is the so important “human factor”. Is there the willingness to change (for example, turn legacy operations into more collaborative operations), do people have a wide enough view on what collaboration could bring for themselves and for other partners, do cultural differences stimulate or prevent collaboration, etc.? And last but definitely not least: trust!!

Then there are the market aspects. For example, in a monopolistic market, those parties holding that position will probably not be very eager to change. Another example is that intensified collaboration and/or automation can eventually disrupt the market. Potential disruption can lead to resistance by the “old players”, which can prevent new players from stepping in.

Also important are the operational challenges: can data sharing easily be established, and if yes, is the quality of the data exchange/ data sharing satisfying and consistent 24/7?

Interdependency between the items? Yes, for example, if competition law forbids cooperation, then it puts a hold on things. Not so long ago, for example EU’s DG-Comp no longer allows Ocean Liners to cooperate on certain operational matters (the so-called Block Exemption Regulation).

3.1.5.1.2 *Improvements in cooperation*

Influencing actors in such a way that they become more willing to look at potential benefits is definitely worthwhile. Influencing could be done in many ways: workshops, conferences, etc. and also convincing policymakers/regulators to stimulate collaboration.

When stepping into a collaborative project or even when just discussing potential cooperation, the objectives, way forward, etc., should be made very clear and transparent. All communication should be as proactive as possible. This is all about managing a change; so, Change Management principles should be respected and followed.

Last but not least, another possibility to explore is the creation of more “Public Private Partnerships”.

3.1.5.1.3 *Platforms and/or Processes*

When it comes to using and/or setting up Platforms/Processes where many actors are involved, good governance is absolutely key!

Other than that, there are already a high number of possibilities available. Tools developed in funded projects like Phoenix and Federated, dataspaces, Nextport, Portbase, Project 44, Transporeon, etc.

Thus, through the discussion, an interesting suggestion came up: ETP-ALICE would be ‘the’ actor who could offer, what could be called, “platform services”

3.1.5.1.4 *Cross-organisation integration*

When discussing this topic, a lot of the elements already listed under “Challenges in collaboration” again came up. Additional ones included “what is in it for me?”, and Supply Chain KPI’s of respective actors may be conflicting.



The question was asked, but remains unanswered, whether or not Zero-Emission regulation will force parties to cooperate?

3.1.5.1.5 *Shared risk and reward models*

The outcomes of these discussions were almost similar to what was already mentioned above. Worthwhile to mention is the question, in line with the question above: can CO2 reduction be used as a reward? Also interesting to explore further are existing “Gain/Loss Sharing” contractual arrangements which have already existed for a long time between LSP’s, and between LSP’s and their customers!

3.1.5.2 *Conclusion for Canvas 5*

In this canvas, the technological aspects of collaboration/automation were not highlighted so much, as matters about, in a broad sense, “human aspects” were underlined, like:

- Need for good and transparent governance
- Proper management of the change
- The question “what is in it for me?” or in other words, “how to share gain/loss?” or “win/win”
- Mindset/Mindshift

Workshop’s discussions and history (and not just supply chain history) show that overcoming these challenges has always been, and will continue to be, a complex and demanding task, and it may therefore be useful to look back and examine why certain past initiatives succeeded while others failed. For example, some experts mentioned that in Germany, the concept of “System transport” offered a model where different logistics service providers managed to collaborate effectively, delivering high-quality service to customers while sharing both risks and rewards. In contrast, other ambitious initiatives aimed at enabling large-scale data sharing and interoperability struggled to gain widespread adoption and ultimately came to an end. These cases highlight the importance of aligning interests, building trust, and ensuring mutual value creation, all of which remain essential for any collaborative logistics ecosystem to thrive.

3.2 1st Phase – Step 2: The workshop in Trieste

The workshop in Trieste, held in December 2024 (see agenda in Annex II - Agenda of the workshop in Trieste), was a valuable opportunity for dialogue among various local stakeholders and partners of the AUTOSUP project. The workshop has two main parts: in the first part (in the morning session) the main aspects of the projects have been outlined with the presentation of the use case. Followed by the second part, where the session canvas had a place.

The day began with a welcome by [Adriafer](#) S.p.A and a brief introduction of the participants, which included representatives from Adriafer, the Friuli Venezia Giulia Region, the [Port Network Authority of the Eastern Adriatic Sea – Ports of Trieste and Monfalcone](#), associations like as [the European Network of Logistics Competence Centres \(OPEN ENLoCC\)](#), or operators like as the [Interporto Padova](#), [University of Rome DITS](#) (from [AutoMoTIF](#) twin Project), other companies on this field and other regional companies (see table below). The event continued with a general presentation of the AUTOSUP project, outlining its vision for logistics automation, followed by a classification of automation technologies (as first output Deliverable 1.1).



Table 3-2: Organizations participated in the workshop in Trieste

Organization names	
Adriafer Rail Services	University of Rome DITS
ALICE	OPEN ENLoCC
DITS SRL	Friuli Venezia Giulia Region
Info.Era S.r.l.	Port Network Authority of the Eastern Adriatic Sea
FIT consulting	Ports of Trieste and Monfalcone
Gruber logistics	Autamarocchi SpA
Mermec	ABS
CFLI	ELEVANTE
Pigreco FVG Srl	Interporto Padova
CMA-CGM	PITTINI
Mediterranea Srl.	

CFLI introduced the D1.1 “Classification of Logistics Automation technologies”, which inspired the discussion of the second part of the workshop. FIT Consulting also presented the different “Use case scenarios” definition to help the discussion among stakeholders, but limited to the subject of the AUTOSUP use cases

Subsequently, two use cases related to Trieste were presented. The first on “automation and predictive maintenance” was introduced by Adriafer, with some detail on the line of presentation highlighted in the workshop in Antwerp. While the second use case on “automation in last-mile route” was described by [Gruber Logistics](#). The partners highlighted the opportunities and challenges of automation in real-world contexts.

In the second part of the workshop, the focus shifted to *requirements, needs, and gaps*. ALICE ETP presented the outcomes of the Antwerp workshop held in September (as further described in chapter 3.1), initiating a discussion that highlighted several issues.

Some discussions were raised, particularly the lack of data communication standards between different countries, such as between Italy and Turkey (this reflects indeed the actual objective of Use case 2 in Trieste). Many reflections raised by actors concern innovation, technologies, and implementation aspects. For instance, on the technological aspect, although platform leaders in the market provide intermodal solutions, concerns remain about data management outside the EU and compliance with European regulations.

A key point of the workshop was Gruber Logistics’ case study (Trieste UC2). The company is working on a Decision Support System (DSS) to improve first- and last-mile logistics management. The main features include:

- Optimization of carrier selection and delay decisions.



- Enhanced information on the actual transport status.
- Data integration across various systems (PCS, eFTI, internal systems).
- Reduction of errors through unified data entry.

The Interporto Padova also shared an especially interesting case related to automation and digitalization. Key projects in progress include:

- Automation of portal cranes, which will be remotely operated starting in 2025, with full automation planned in subsequent years.
- Use of drones for surveillance and security, equipped with AI systems to detect intrusions or anomalies in semi-trailers and containers.
- Development of proprietary software for logistics management, initiated in 2018. This approach enables greater customization and strategic planning compared to off-the-shelf market solutions. Padova is also considering patenting and commercializing these technologies.

During the final part of the discussion, the [Council of Supply Chain Management Professionals](#) highlighted Italy's delay in adopting advanced digital systems like TMS (Transport Management Systems). He also noted that many Italian companies continue to operate *ex works* (at the factory gate), losing control over costs and efficiency in the logistics chain.

The workshop has been an opportunity for partners to analyse the Italian case study (Trieste Living Hub) and for actors to be updated on the current opportunities and challenges on this topic. What mainly emerges is the need to standardize data management and develop federated platforms for freight villages was emphasized to improve interoperability and address issues related to technological integration. However, it was noted that such initiatives can succeed only if supported by clear business advantages.

3.2.1 Identification of requirements, needs and gaps

3.2.1.1 Session 1: Interoperability and Technological Integration

- **Context Introduction:** Interoperability and technological integration are key challenges for multimodal logistics automation. Discussions focused on difficulties in linking legacy systems with new technologies and the need for communication standards between nations, such as between Italy and Turkey.
- **Padova case:** Interporto Padova presented its proprietary approach to technology with an internally developed TMS, enabling complete integration and long-term planning. They are considering patenting and possibly commercializing their software.
- **Interoperability Issues:** Lack of common standards for IoT, TOS, PCS, and customs platforms. Some IT platforms, while useful for trucks and intermodal logistics, raises concerns over data management outside the EU.
- **Automation in ports and freight hubs:** While ports have PCS systems, freight hubs lack similar platforms. There is a need for a federation of freight hubs to unify data on a common platform.

Key Points are:

- The need for communication standards between nations (e.g., Italy and Turkey).
- Value of proprietary systems to meet specific needs.



- Federating freight hubs to ensure interoperability and data sharing.
- Concerns over using non-EU platforms for data management.

3.2.1.2 Session 2: Impacts of Automation on Personnel

- **Demographics and Localization:** Automation could mitigate workforce shortages and encourage the re-localization of factories and terminals to Europe.
- **Exoskeletons and Robots:** New technologies such as exoskeletons, robots, and cobots are being used in warehouses to assist workers.
- **Padova:** The Padova freight terminal is working on remote-controlled cranes, which will be fully automated within a few years. This reduces health risks for operators and enhances operational safety.
- **Identified Issues:** Resistance to change and the need for continuous training to manage complex systems.

Key Points are:

- Opportunities to re-localize activities due to automation.
- Utilizing innovative technologies to enhance safety and productivity.
- Importance of training and overcoming resistance to change.
- Remote operation of cranes and a focus on operational safety.

3.2.1.3 Session 3: Legal, Ethical and Security Aspects

- **Data Protection:** Challenges arise in data sharing among operators, especially when data is managed by IT platform hosted on servers outside the EU, which must still comply with GDPR.
- **Padova case:** Use of autonomous drones to monitor the security of semi-trailers and containers. The AI-based system detects anomalies and intrusions.
- **Cybersecurity:** Lack of standards and certifications for automated systems. The need for advanced security strategies such as VPNs, two-factor authentication, and disconnected backups.

Legislation: Standardized regulations are needed for automated operations, including managing incidents with autonomous vehicles.

Key Points are:

- Need for legal and regulatory frameworks for security and data management.
- Integration of advanced security tools into logistics systems.
- Innovative use of drones for security and monitoring.
- Development of holistic certifications for integrated technologies.

3.2.1.4 Session 4: Costs and Benefits of Automation

- **Initial Investments:** Automation requires high upfront costs for R&D, infrastructure, and training. However, benefits include improved operational efficiency and long-term savings.
- **Padova case:** The proprietary approach to automation reduces operational costs and ensures high data quality.



- **Sustainability:** Automation helps reduce environmental impact and optimizes resource usage.

Economic Drivers: Identifying sustainable business models is essential to promote the adoption of automated systems.

Key Points are:

- High initial costs are offset by long-term benefits and savings.
- Reduction of environmental impact and improved efficiency.
- Need for business models that incentivize automation adoption.
- Importance of proprietary systems to contain operational costs.

3.2.1.5 Session 5: Collaboration Among Supply Chain Actors and Interdependencies

- **Collaboration Challenges:** Lack of trust, cultural differences, and technical barriers hinder integration among supply chain actors.
- **Shared Risk and Reward Models:** Need for agreements that equitably distribute risks and benefits, such as “gain/loss sharing” contracts.
- **Proposed Initiatives:** Develop open collaborative platforms to stimulate cooperation, as suggested by ALICE and participants.
- **Success Stories:** Padova demonstrated how an internal, integrated approach can be an example for other organizations.

Key Points are:

- Overcoming cultural and technical barriers to improve collaboration.
- Promoting shared platforms for data exchange.
- Creating win-win agreements for risk and benefit management in the supply chain.
- Leveraging local initiatives like Padua to foster innovation.

3.3 2nd Phase: Stakeholders Interviews and Questionnaires

The second and last phase of requirements analysis for the AUTOSUP project, was conducted in the form of questionnaires and interviews. An interview is essentially a structured conversation where one participant asks questions, and the other provides answers. Interviews can range from Unstructured interviews or free-wheeling and open-ended conversations in which there is no predetermined plan with



prearranged questions³, to highly structured conversations in which specific questions occur in a specified order⁴.

In AUTOSUP, semi-structured interviews were conducted, using the questionnaire as a guide for discussion rather than a strict set of questions, with the main goal to understand the interviewees' perspectives on logistics automation and gather insights into their roles, experiences, and expectations. Interviews offered flexibility and depth, allowing the AUTOSUP team to explore complex topics in more detail, enhancing the quality of data collected, and contributing rich qualitative insights that informed robust and context-sensitive requirements analysis.

On the other hand, the use of questionnaires allowed the project team to efficiently gather a wide range of responses, facilitating quantitative/qualitative analysis and comparative benchmarking. This method provided a comprehensive understanding of stakeholder needs, enabled the identification of common challenges across different transport modes, and informed the prioritization of requirements based on the prevalence and importance of specific issues.

3.3.1 . Structure of the questionnaire

The questionnaire (see Annex III - Questionnaire to the experts) was divided into several sections, each focusing on a specific topic related to logistics automation, but of course started with an introduction to the AUTOSUP project, its objectives, and information on the work done so far, including the two workshops held in Antwerp and Trieste.

In each section, an intro to the topic and a context were included, with the aim of understanding the interviewee's point of view on logistics automation. The questions were adapted depending on the interviewee's background (logistics operator, association, research centre, or policy network):

- **Interoperability:** Focused on collecting input regarding the requirements to improve integration between logistics nodes and corridors, with particular attention to interoperability challenges linked to automation.
- **Human-Machine Interaction (HMI):** Aimed at understanding training and operational needs for effective interaction between people and automated systems.
- **Cybersecurity and Legal Aspects:** Covered legal and cybersecurity requirements necessary to ensure the safety, compliance, and resilience of automated logistics systems.
- **Requirements and Roadmap Definition:** Focused on identifying the key requirements to accelerate logistics automation and setting priorities for a future roadmap.
- **Feasibility and Investment Analysis:** Explored financial and strategic factors that influence the adoption of automation in logistics.

³ Yale, J.R. 1945. *Frontier Thinking in Guidance*. Chicago, IL: Science Research Associates.

⁴ Kvale, S., Brinkman, S. 2009. *Interviews: Learning the Craft of Qualitative Research Interviewing*. 2nd edit. Thousand Oaks, CA: Sage.



- Sustainability Aspects (Optional): In some cases, the questionnaire also included questions about how automation could contribute to reducing greenhouse gas emissions
- Conclusions: Finally, interviewees were given the chance to share any additional thoughts and express their interest in continuing the dialogue with the AUTOSUP project.

The questionnaire was not meant to be followed rigidly but rather used as a flexible framework for meaningful conversations. Interviewers were encouraged to adapt their questions based on the expertise and role of each interviewee, indeed, all interviews were carried out directly by members of the AUTOSUP expert team. The focus was on external experts and associations, in order to gather in-depth insights into technical, operational, and regulatory requirements for automation.

3.3.2 . Interviewees and responders profile

The Organizations which participated in the interviews/survey are quite homogeneous. Looking at the graph below, it is possible to see that almost all of them have the same weight. This guarantees a more homogeneous type of answer.

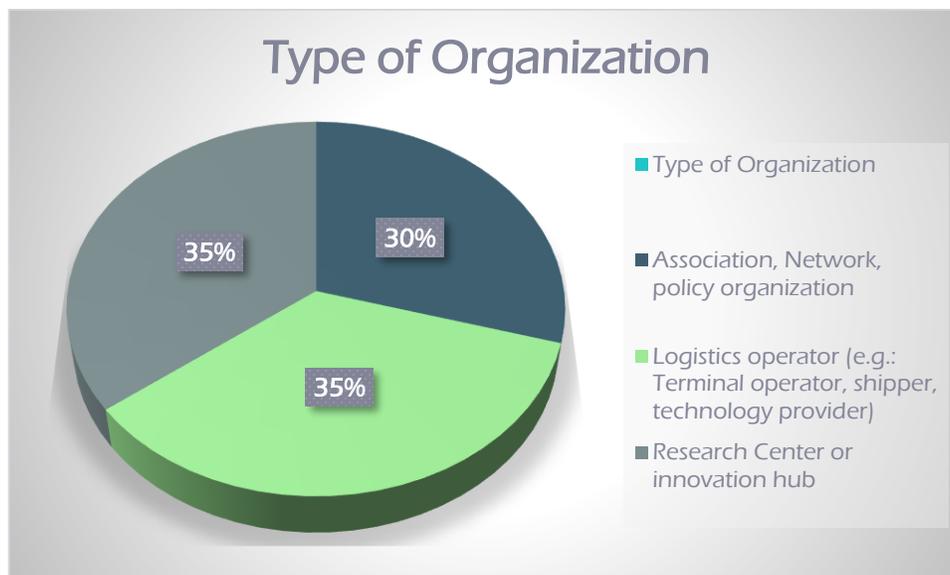


Figure 3-1: Type of Organizations that participated in the questionnaire and interviews

More specifically, the organisations that participated in the questionnaire and the interviews are depicted in the table below. The contribution of these organisations was significant in the validation and finalisation of the requirements identification.

Table 3-3: Organizations that participated in the questionnaire and interviews

Organization name
North Adriatic Sea Port Authority - Ports of Venice and Chioggia
TNO
Sirma Group
Esercizio Raccordi Ferroviari di Porto Marghera S.p.A.
GEVATRANS PC



Nevomo
CPLS - Sines Port and Logistics Community
VIL
Port Network Authority of the Eastern Adriatic Sea
Circle Group
Universitatea Dunarea de Jos din Galati
CeNTI
VICOMTECH
Studio Ballarin
Port of Rotterdam
GRUBER LOGISTICS
Frontier Innovations



4 Consolidated Requirements Analysis

This chapter sums up the requirements for seamless multimodal automatic freight transport gathered through the workshops in Antwerp and Trieste, as well as expert interviews. It provides a structured and prioritized overview of these requirements, considering the classification of automation technologies defined in Deliverable D1.1 and the operational contexts of the Use Case Scenarios outlined in Task 1.3.

As mentioned in the introduction of this deliverable, automation is becoming increasingly important in modern supply chains, promising improvements in the efficiency, safety, and sustainability of logistics operations. Companies across the logistics sector are adopting autonomous and semi-autonomous technologies, from automated warehouses to autonomous vehicles, driven by the potential for cost reduction and faster throughput. However, realizing these benefits requires a holistic and strategic approach. Logistics automation faces significant challenges such as regulatory obstacles and cybersecurity risks, which means that logistics players must plan beyond mere technology deployment. A broad, integrated strategy is needed to break down silos and ensure all components of the supply chain work seamlessly together toward end-to-end automation.

In this context, a holistic approach that addresses technical, operational, social, and organizational aspects at the same time is needed. Instead of isolated solutions, stakeholders should aim for seamless integration across different logistics functions and modes (and this is not only valid for automation). Removing silos, for example technological between IT systems or organizational between departments, is crucial for achieving true automation along the entire supply chain. Currently, many logistics processes suffer from fragmentation. For example, from the interviews, it emerged that one of the main problems is the fragmentation of data flows and the disconnected systems, which are leading to inefficiencies and communication gaps. Focusing on integration could be a solution to overcome these gaps and create a good environment for synchronized digital ecosystems, improving collaboration and real-time visibility across the supply chain.

In this way, automation in logistics is not just about introducing robots or software in one area; but on the contrary, it's about integrating people, processes, data, and technology across the entire logistics network to enable seamless, 24/7 operations.

4.1 Grouping of Requirements by Cross-Cutting Theme

To achieve seamless automation in logistics, several key requirement areas must be addressed. These requirements, identified through AUTOSUP workshops and stakeholder interviews, span technical standards, security, legal frameworks, data sharing, human factors, and economic/sustainability considerations. Being focused on these wide topics ensures that automation initiatives are aligned with strategic needs and, at the same time, are also practical (feasible in real operational contexts).

In this chapter the identified needs for seamless multimodal automatic freight transport are categorized into the following main themes. These categories will represent the key areas that emerged from discussions with stakeholders, and are:

- Interoperability and technical integration
- Security
- Legal and Regulatory Aspects
- Data Management and Information Sharing
- Impact on Personnel
- Economic and Sustainability Aspects



4.1.1 Interoperability and technical integration

Interoperability is the ability of different systems, devices, and organizations to work together, and it is considered one of the cornerstones of logistics automation. Without common standards and interfaces, automated components in the supply chain cannot effectively communicate. Stakeholder workshops revealed that a lack of interoperability between logistics platforms (for example, Terminal Operating Systems, Port Community Systems, and customs systems) is a major barrier to automation. Currently, many ports and logistics hubs use different systems that are not able to “talk” to each other. This means that operators are obliged to re-enter data manually, leading to typos, errors and information gaps. Establishing common data standards and communication protocols is therefore essential. Participants in AUTOSUP discussions stressed the importance of neutral, cross-industry bodies to foster standardization and data exchange frameworks. This standardization would enable, for instance, an autonomous vehicle at a port to seamlessly exchange information with warehouse robotics or a rail terminal’s software.

From the workshop in Trieste, it emerged that interoperability also has a critical cross-border dimension. In international logistics corridors, different countries and regions may use various systems and data formats. Without alignment, automated processes could fall into jurisdictional boundaries and bureaucracy. For example, a lack of universal standards for data exchange among hubs and transport operators leads to fragmentation and inefficiencies. Although this problem soon should be overcome by the introduction of the eFTI with a standard of communication B2A. From the consequent eCMR for communications B2B, stakeholders highlighted the need for international communication standards so that an automated supply chain can function smoothly even when shipments move between different digital environments (e.g. between an EU port and a non-EU port, linked to the use case 2 in Trieste).

From the interviews there is a clear message which supports the idea to create federated data platforms for freight hubs, using data with a common structure to avoid silos. This platform would aggregate information from multiple nodes (ports, rail terminals, distribution centres).

Standardization and interoperability efforts, including standard data formats, open APIs, and industry-wide protocols, are fundamental requirements. Indeed, they enable the possibility to integrate different automation technologies along the supply chain, preventing the creation of isolated automation “islands” and ensuring end-to-end process coherence.

4.1.2 Security and Safety (including data privacy)

Logistics is becoming data-driven and more automated and digitally interconnected. Security, especially the cyber dimension, emerges as a critical requirement for the correct and seamless integration of systems in the supply chain. Indeed, modern logistics relies on data to optimize operations, improve efficiency, and enhance customer experiences. This data-driven approach involves collecting, analysing, and utilizing large amounts of information from various sources, such as sensors, tracking devices, enterprise systems and external information. So, the first requirement is that automated logistics systems must be safe from accidents and resilient against cyberattacks. Safe means protecting data, system integrity, and the physical safety of goods and personnel as everything is now interconnected.

Experts and stakeholders mentioned this during the interviews and the workshops and the synthesis is that increased connectivity opens new vulnerabilities, for example, automated and connected vehicles are prone to cyberattacks such as system tampering or data and GPS data manipulation. A malicious attack on an autonomous truck or a port’s automated cranes could disrupt operations or even cause accidents. Ensuring robust cybersecurity measures, like as encryption, authentication, and intrusion detection, is therefore paramount to prevent unauthorized access.



Data protection is one of the main points related to security in automated logistics. Companies are reluctant to share data because of confidentiality and competitive concerns, and this is what should be overcome, as it is evident that the creation of a common data space would be beneficial for all the actors. But in a fully automated supply chain, large volumes of operational data are exchanged between the several actors involved in the transport chain. Good protection from data breaches is essential to maintain a high level of trust and to allow more actors to exchange their data in a secure way, generating a snowball effect which welcomes new actors available to share their data. Additionally, companies must be compliant with privacy regulations like as GDPR, which is essential nowadays. And this requirement is not always clear at 100%, as many IT systems that collect sensitive data are located in countries that are not required to comply with European laws and regulations. For example, IT operators who provide and are also market leaders in the development and distribution of systems like Terminal Operating Systems (TOS) or Transportation Management Systems (TMS) are often located outside Europe, and there is no certainty that the data of European customers are stored on servers that comply with GDPR requirements.

AUTOSUP interviews and workshops (especially the one in Trieste) underlined that the lack of cybersecurity standards and certification is a gap. The logistics industry would benefit from common security standards and a certification process to validate that a given automation solution meets minimum security criteria. The lack of these standards generates uncertainty and risks for data protection, therefore, it is crucial to develop and implement global security standards and certification processes that ensure compliance with data protection requirements, regardless of the server's location.

A last concern on data security issues is related to contingency planning. As the logistics industry operates 24/7, a fully automated supply chain (containing interdependent and interrelated infrastructures and services) can create single points of failure; if one of the systems is attacked or fails, the entire chain could have problems. To address this risk, stakeholders recommended measures like manual override capabilities (allowing human intervention if automation fails) and isolated backup systems that can take over in emergencies.

Finally, physical security and safety systems must evolve alongside automation, safeguarding automated equipment from tampering and ensuring that robots or autonomous vehicles have fail-safes to prevent accidents. Cybersecurity and safety requirements are deeply interconnected with [legal aspects](#) due to the unclear liability, and current regulations could leave gaps in enforcement.

4.1.3 Legal and Regulatory Aspects

The legal and regulatory frameworks play a pivotal role in enabling automation in logistics, as they can easily create or remove barriers, which are often one of the main obstacles or opportunities for companies, directly influencing their decision to invest in automated solutions and to share or exchange data with other actors. Key issues, such as liability, still lack clear and specific answers. As a result, companies that are ready to invest in automated trucks may not be allowed to operate them on public roads or in certain terminals simply because infrastructure owners are uncertain about their legal responsibilities in the event of an accident. Regulations do not always provide definitive answers, resulting in an unregulated level of risk that policymakers need to address by defining clear responsibilities and insurance mechanisms.

Moreover, current transport and safety regulations may need adaptation to allow certain automated operations. For example, rules about trucks on public roads, or labour regulations in ports could limit the use of driverless vehicles or automated cranes if not revised. A unified regulatory framework, at least at the EU level is highly desirable to avoid that each country might have different rules, complicating cross-border automated logistics, while harmonizing these regulations (for example, common rules for



autonomous truck platooning on highways across Europe) would greatly smooth the deployment of automation along international corridors.

Regulatory bodies and standards organizations should also work on certification processes for automation technologies in a holistic certification of integrated systems, rather than certifying each individual piece of equipment in isolation. This would ensure that when multiple automated components interact (e.g., a drone surveillance system feeding into an automated gate control), the entire system meets safety and reliability standards.

Another aspect of the legal framework is ensuring compliance with existing laws, such as labor laws, data protection laws, and environmental regulations. Automation must be implemented in a way that respects workers' rights (for example, adhering to work-hour restrictions even if remote operators replace drivers) and privacy laws (especially if cameras or sensors are collecting data).

Moreover, insights from the workshop in Trieste indicate that developing the legal framework for automation is not just the job of governments. However, industry collaboration is key, for example by the development of multi-stakeholder forums involving several actors from different environments and projects, such as technology providers, logistics companies, insurers, research organization, IT developers and regulators, can help shape guidelines that are both practical and enforceable.

It should be noted that many legal and regulatory aspects and requirements overlap with security aspects above, and data management aspects below, as they have a crosscutting nature.

4.1.4 Data Management and Information Sharing

As mentioned in this document, logistics is heavily data-driven, and automated systems rely on accurate, real-time information to make decisions (e.g., IoT sensors in containers, real-time vehicle locations, or inventory levels in automated warehouses generate and consume massive amounts of data). For this reason, it is necessary to have robust data management and information sharing guidelines to increase the ability to efficiently handle large-scale logistics data. This includes having infrastructure for big data storage and processing (potentially cloud or edge computing solutions), and ensuring data quality (consistent, clean data inputs for automation algorithms). In a logistics ecosystem in which there are no single entities that operate end-to-end logistics (carriers, warehouse operators, rail freight carriers, customs, port authorities, shippers, and technology providers all need to exchange information), equally important is establishing secure and standardized data-sharing mechanisms among different actors of the supply chain. If each of them is using a different format or platform, the automation benefits will be lost in translation, which includes more and more complexity in an already crowded supply chain. This is the main reason to have interoperable data sharing, with standard and common data models (for shipments, events, etc.) which are able to activate systems to exchange information. As noted earlier, the absence of universal data exchange standards, and a shared data language, today leads to fragmentation in the information. To overcome this lack requires not just technology, but also governance agreements to have companies willing to share and exchange data. Interviews highlighted that shippers and logistics providers are sometimes reluctant to share information due to confidentiality and competitive concerns. It is important to build trust through secure data-sharing platforms, possibly neutral platforms or using technologies like blockchain for traceability and provide incentives for data sharing. From an operational perspective, data sharing leads to greater supply chain visibility, for example, integrating a logistics provider's Transportation Management System with other stakeholders' digital platforms creates a synchronized ecosystem where all parties have a real-time tracking which allows automated systems, but also human managers, to make adaptive decisions, reducing delays and increasing the efficiency along the supply chain.



A concrete requirement is implementing paperless processes and digital documentation in logistics, which starting from 2027 will be mandatory in the EU in the communication between Business to Administration, thanks to the introduction of the eFTI regulation⁵. Automation struggles in processes that still rely on paper forms or siloed databases. By digitizing documents like transport orders, customs forms, and delivery receipts – and enabling their automatic sharing – delays due to paperwork can be eliminated. In an automated logistics supply chain, a Decision Support System (DSS) could automatically generate and disseminate required documents and updates to all relevant actors, ensuring everyone is working with the same information in real-time from different perspectives.

Security and Safety (including data privacy)(see chapter 4.1.2 above) are relevant here as information sharing must be done securely and with access controls so that each stakeholder sees what they are authorized to see, and sensitive data is protected. Solutions like distributed dataspace and databases or controlled-access data hubs may facilitate this approach, but the key point is that information silos must be broken down. Whether via industry data hubs, standardized APIs, agreed data-sharing protocols, or hopefully with the creation of a data-shared language, logistics automation needs data to flow freely and securely from end to end. If data management and sharing, and cross-border compatibility are handled well, the outcome is improved decision-making and coordination, and automated systems can optimize routes and loads with full knowledge of upstream and downstream conditions, while human planners can have a complete real-time picture of operations (situational awareness and common operational picture) to supervise effectively.

4.1.5 Impact on Personnel

Automation doesn't just transform systems; it transforms the workforce and roles within logistics. Any strategic approach to automation must include requirements related to personnel impact, covering workforce transition, training, and human-machine interaction (HMI). Rather than viewing automation purely as a way to replace labor, leading organizations frame it as a way to augment human capabilities, address labor shortages, and improve the labor conditions of workers. In logistics (which is currently facing driver shortages, etc.), automation can take over repetitive or dangerous tasks, while humans move into supervisory and decision-making roles. However, this transition requires careful management. In this context, workforce adaptation and training are key requirements, as employees need new skills like operating and maintaining automated systems, analysing data, or managing exceptions when the automated flow encounters a problem.

Experts indicate that logistics roles are shifting from pure manual execution to monitoring and exception handling. For example, a port crane operator, or the captain of a barge, might transition from physically operating machinery to overseeing multiple automated cranes or ships from a control room. This demands ICT skills and comfort with advanced Human-Machine Interfaces. Training programs should be developed to help current staff acquire IT and problem-solving skills needed in more automated

⁵ For more information please visit the official website https://transport.ec.europa.eu/transport-themes/logistics-and-multimodal-transport/efti-regulation_en



environments. One interesting observation was that new talent profiles may emerge, like people with backgrounds in gaming or IT, combined with logistics knowledge, could excel in managing automated or remote operations. The requirement here is for companies to anticipate these skill needs and begin reskilling or hiring accordingly.

Another critical aspect that emerged, especially during the two workshops, is how to manage change and cultural acceptance. Automation can trigger fear of job loss and resistance among workers, and in some cases, it is the truth. In sectors like ports, where there are strong labor unions, automation plans are perceived as a process to reduce the human factor. Requirements for communication and engagement are key to involving employees early, clearly communicating the benefits of automation, which can reduce the load of exhausting work and improve safety, offering assurances. Stakeholders emphasized strategies like staggered training programs to introduce automation in phases so workers gradually adapt, and using pilot projects or demonstrations to show employees how new technology will work in practice, maybe showing the added value. These pilots can help demystify automation and reduce anxiety by proving that workers remain a central part of operations, just with different tools. In this context, Research and Innovation projects like Horizon Europe or Interreg Programmes are contributing to this scope.

As for the workforce safety, automation can improve it by handling hazardous tasks, for example using automated systems in chemical warehouses, or using drones to inspect hard-to-reach infrastructure. In one example, a freight terminal is transitioning to remote-controlled and eventually fully automated cranes, which takes human operators out of harm's way, removing the need to climb up cranes in bad weather or handle heavy loads directly. The requirement is to ensure that such changes genuinely benefit workers, reducing accidents and that any new risks introduced by automation are managed. Human-Machine Interaction (HMI) design needs to be intuitive, with interfaces that make it easy for personnel to interact with automation systems effectively and safely.

4.1.6 Economic and Sustainability Aspects

Any discussion of automation requirements must consider the economic viability and sustainability of these solutions. Automation investments in logistics are significant, so understanding the cost-benefit and ensuring long-term sustainability is a key requirement. Going into more detail, it is important to demonstrate the cost-effectiveness of automated systems, which should either reduce operating costs or increase productivity (or both) enough to justify their upfront expense. For instance, automated processes can minimize errors and improve asset utilization. In the AUTOSUP use cases, it was noted that predictive maintenance and automation in rail freight can lower maintenance costs and reduce unplanned downtime, extending the life of assets like wagons on the one hand, and tracks (which are precious, especially in port areas) on the other hand. By minimizing disruptions and keeping equipment in service longer, companies save money and improve service levels.

Another economic benefit is throughput and efficiency gains. Automation, such as robotic loading systems can significantly cut loading/unloading times and allow 24-hour operations. These efficiency improvements translate to better capacity use of infrastructure (e.g., more containers or railcars handled per day) and thus better return on assets. They also improve reliability – automated systems can run with fewer breaks, which improves on-time performance and customer satisfaction. From a requirements point of view, companies should set KPIs for automation projects, such as target reductions in turnaround time, increases in volume handled, or cost per unit moved, to ensure the economic goals are clear and measured.

On the environmental sustainability side, automation can contribute heavily to environmental objectives. A strategic requirement is that automation initiatives align with sustainability goals like reducing emissions, energy usage, and waste generation. For example, shifting more freight from road to rail or



water through automation (since automation can make these modes more efficient and attractive) leads to lower carbon emissions per ton-km. In the Trieste hub use case, it's projected that moving freight via automated intermodal processes (road-to-rail) will substantially cut CO₂ emissions. Automation can also enable smarter energy management through IoT-enabled systems which are able to optimize fuel or electricity usage (turning off equipment when idle, optimizing driving patterns for autonomous vehicles, etc.). Additionally, reducing congestion through better coordination (e.g., trucks spend less time idling at gates due to automated scheduling) further cuts emissions, local pollution and costs.

The reduced waste and better resource utilization can be significantly enhanced thanks to solutions like as automating planning with AI and real-time data, so that companies can avoid sending half-empty trucks or unnecessary trips, which means less fuel burned for the same logistics output. Therefore, a requirement is to integrate sustainability metrics, for instance, to track emission reductions, energy efficiency improvements, or the percentage of cargo shifted to lower-emission transport modes as a result of automation. Many stakeholders and customers are increasingly evaluating logistics through a sustainability lens, so automation must deliver environmental benefits to be future-proof.

Each automation initiative should consider a business case, not just the technology for its own sake, but how it drives sustainable ROI in the overall logistics processes and supports environmental and social responsibility targets. In doing so, logistics providers can ensure that automation contributes to long-term economic viability and a greener supply chain rather than creating excessive costs or unintended environmental consequences.

4.1.7 Main points of needs and barriers towards an automated supply chain

Based on the consolidated findings above, the key requirements within each major category identified from stakeholder inputs (workshops, questionnaires, and interviews) are summarized as follows:

Table 4-1: Key Requirements

Category	No	Description
Interoperability and Standardization (STD)	STD1	Common data standards and communication protocols between logistics platforms.
	STD2	Cross-border standardization and standardized workflows for seamless multimodal logistics, especially within international corridors.
	STD3	Federated data platforms for freight hubs, avoiding data silos through common data structures.
Security (SEC)	SEC1	Robust cybersecurity measures, including encryption, authentication, and intrusion detection systems
	SEC2	Clear cybersecurity certification processes and standards for integrated systems.
	SEC3	Data protection measures compliant with GDPR, especially considering data storage and processing locations.
	SEC4	Regular security audits, penetration testing, and cybersecurity training for personnel, including emergency scenarios through serious games and simulations.
	SEC5	Advanced or even manual contingency planning measures to handle potential disruptions



Category	No	Description
Legal and Regulatory Frameworks (REG)	REG1	Clear liability frameworks defining responsibilities and insurance mechanisms for automated transport operations.
	REG2	Unified regulatory frameworks at the EU level for harmonizing automated logistics operations
	REG3	Holistic certification processes for integrated systems
	REG4	Compliance with existing labor, privacy, and environmental regulations
Data Management and Information Sharing (DAT)	DAT1	Robust data management guidelines to efficiently handle large-scale logistics data
	DAT2	Secure, standardized data-sharing mechanisms to facilitate real-time information exchange
	DAT3	paperless processes and digital documentation aligned with the eFTI regulation
	DAT4	Governance agreements fostering trust and willingness to share data among logistics providers
Human Factors (HUM)	HUM1	Workforce adaptation through structured training programs focused on ICT skills, automation management, and human-machine interfaces (HMI).
	HUM2	Emphasizing clear communication and showcasing automation benefits through practical demonstrations and pilot projects
Economic and Sustainability Aspects (ECO)	ECO1	Clearly defined economic KPIs for automation projects
	ECO2	Demonstrable economic benefits from automation investments
	ECO3	Alignment of automation projects with sustainability goals
	ECO4	Integration of sustainability metrics into the operational assessment
Interdependencies and Collaborations (COL)	COL1	Governance frameworks and shared risk-reward models to enhance collaboration and trust among stakeholders.
	COL2	Early and comprehensive stakeholder engagement to ensure digital integration
	COL3	Data exchange and cooperation across business, operational, and IT teams to enhance overall efficiency and reduce operational bottlenecks

These key requirements summarize the main areas of focus necessary to achieve successful and seamless automation within multimodal freight transport, as highlighted in the previous chapters of this document.



5 Conclusions / Future Work

Automation in logistics holds immense promise, but it will only deliver on that promise if implemented in a comprehensive, well-coordinated manner. In this document, we outlined the key requirements spanning technical, security, legal, data, human, and economic domains. In particular, we would like to give prioritization to these recommendations without considering the single categorization as in the previous paragraphs, in particular:

1. Integration is the king: Strengthening interoperability frameworks, particularly for seamless data exchange and system integration across different transport modes and technology platforms.
2. Trust and security are paramount for the adoption: Updating cybersecurity protocols and establishing certification processes to ensure secure integration of automated systems and prevent vulnerabilities.
3. Development of clear liability frameworks and regulations to address legal uncertainties surrounding automated transport operations.
4. Creating standardized data-sharing protocols to facilitate seamless information exchange among stakeholders and enhance transparency across multimodal transport networks.
5. People remain central, prioritizing workforce training, upskilling programs, and effective change management strategies to mitigate resistance and facilitate smooth adoption of automation.
6. Automation should advance strategic goals like efficiency gains, cost reduction, and sustainability, establishing financially sustainable models, providing incentives for early adoption, and defining scalable funding mechanisms to encourage investment in automation technologies.
7. -Enhancing stakeholder collaboration by developing governance frameworks, common data spaces, and shared risk-reward models to foster trust and efficient cooperation.

In general, all the actors in the logistics industry, from policymakers and standardization bodies to technology providers and logistics operators, need to collaborate closely, as many of these requirements cannot be solved by one or few organizations alone, indeed, they require industry-wide cooperation and public-private dialogue.

All the aforementioned findings will be considered in the following AUTOSUP's Tasks and WPs, capitalizing on this knowledge and trying to provide handful findings towards seamless multimodal automated freight transport. As such, these needs and barriers will be used to tailor the use cases definition per Living Lab (in D1.3), support the development and implementation of the DTs and the DSS (in WP2), as well as the validation and assessment of all these in WP3.



6 References⁶

- [1] Identec Solution. (2022). Retrieved from <https://www.identecsolutions.com/news/known-port-automation-challenges>
- [2] McKinsey & Company. (2023, November). Retrieved from <https://www.mckinsey.com/capabilities/operations/our-insights/digital-logistics-technology-race-gathers-momentum>

⁶ Most of the information included in this report is the result of discussions with experts and their thoughts about automation in logistics.



Annex I – Agenda of the workshop in Antwerp



Preparing the ground for **AUTO**nomous Multimodal **SUP**ply Chains

Grant Agreement Number: 101147468



**AUTOSUP Workshop: Exploring Requirements,
Gaps and Opportunities of Automation
Technologies in Logistics**

27/9/2024

LOG!VILLE, NIEL, BELGIUM



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N. 101147468



External Stakeholder Workshop Antwerp

Document Summary Information

Acronym	AUTOSUP
Grant Agreement No.	101147468
Meeting ID	AUTOSUP_WP1_WS_ANTWERP_EXT
Date of meeting	27/9/2024
Purpose/Title	External Stakeholder Workshop Antwerp
Location	<u>LOG!VILLE, NIEL, BELGIUM</u>



Goal of the meeting

This workshop aims to bring together experts, stakeholders, and partners to identify the needs and explore the latest automation solutions that can enhance efficiency, sustainability, and competitiveness in logistics. The insights will be invaluable in shaping the direction of the AUTOSUP project.

The automation technologies that are in scope of the workshop are classified into 4 main categories and some subcategories:

- **Mode of transport:** This category highlights automation technologies relevant to road, rail, air and maritime transport. Automation technologies related to vehicles and vessels are here included.
- **Hub and warehouse:** This category is further divided into two sub-categories: Cargo Terminal and Smart Warehouse.
- **Information flows and electronic freight traffic management**
- **Automation technologies for the supply chain as a network**

Expectations of the workshop:

- In-depth discussions on the current state of automation technologies, based on the classification of automations.
- Identification of barriers, needs, gaps and requirements for implementation of automations along the logistics supply chain.
- Exploration of real-world use cases and success stories.
- Identifying gaps and opportunities related to single automations.

No presentations are needed from your side, but it will be appreciated a proactive approach especially during the CANVAS interactive sessions.

27/09/2024

#	Activity Detail	Start Time	End Time	Speaker
1	Welcome	09.00	9.15	Dirk Staelens (VIL)
2	Intro	09.15	9.30	Ilias Gkotsis (INLE)
3	Intro to the classification of automation technologies	9.30	10.00	Marco Mazzarino (CFLI)
4	Living hub Port of Trieste explained	10.00	10.15	Alice Scotti (ARS)
5	Living hub Port of Antwerp-Bruges explained	10.15	10.30	Karen Van Brussel (PoAB)
6	Break	10.30	10.45	
7	Intro to the interactive canvas sessions	10.45	10.55	Giuseppe Luppino and Tomasz Dowgielewicz (ALICE)



External Stakeholder Workshop Antwerp



#	Activity Detail	Start Time	End Time	Speaker
8	Canvas session 1	10.55	11.20	All
9	Canvas session 2	11.20	11.45	All
10	Break	11.45	12.00	
11	Canvas session 3	12.00	12.25	All
12	Canvas session 4	12.25	12.50	All
13	Canvas session 5	12.50	13.15	All
14	Lunch	13.15	14.00	
15	Summary session	14.00	15.00	Giuseppe Luppino (ALICE)
16	End of the meeting	15.00		



www.autosup-project.eu/





External Stakeholder Workshop Antwerp



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Annex II - Agenda of the workshop in Trieste



Preparing the ground for **AUTO**nomous Multimodal **SUP**ply Chains

Grant Agreement Number: 101147468



WORKSHOP IN TRIESTE AGENDA

10/12/2024

MIB TRIESTE SCHOOL OF MANAGEMENT, LARGO CADUTI DI NASSIRIYA 1, TRIESTE



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N. 101147468



Workshop in Trieste Agenda

Document Summary Information

Acronym	AUTOSUP
Grant Agreement No.	101147468
Meeting ID	i.e. PM2_date / TM-WP1_date / ...
Date of meeting	10/12/2024
Purpose/Title	Workshop in Trieste Agenda
Location	MIB TRIESTE SCHOOL OF MANAGEMENT, LARGO CADUTI DI NASSIRIYA 1, TRIESTE



Goal of the meeting

GB English GB	IT Italiano IT
<p>The purpose of this meeting is to identify needs, requirements, and gaps in logistics supply chain automation, focusing on technology integration and interoperability to reduce bottlenecks and foster a more seamless, coordinated automation process. You should have received a study providing a comprehensive classification of the priority automation categories and innovative technologies identified by the AUTOSUP project in terms of readiness, impacts, sustainability, which will serve as the basis for our discussions:</p> <ul style="list-style-type: none"> • Mode of Transport: Automation for road, rail, air, and maritime transport. • Hubs and Warehouses: Focusing on cargo terminals and smart warehouses. • Information Flows and Electronic Freight Traffic Management. • Supply Chain Automation as an Integrated Network. <p>This workshop follows an initial meeting held in Antwerp, where key objectives for multimodal transport and logistics automation were outlined. In Trieste, we will build on this work with a focus on Italian priorities, enriching and deepening the collective vision as well as for presenting the pilot action of the Trieste Living-Lab.</p> <p>The program will feature discussions on the current state of automation technologies, identification of barriers, needs, and requirements for implementation along the logistics supply chain, and exploration of opportunities and challenges.</p> <p>No formal presentations are required; however, an active contribution, particularly during interactive sessions, where your perspectives will be greatly valued, is encouraged.</p>	<p>Il Workshop ha l'obiettivo di identificare i bisogni, i requisiti e i gap per l'automazione della supply chain logistica, con un focus su integrazione e interoperabilità delle tecnologie per ridurre i colli di bottiglia e promuovere un'automazione più fluida e coordinata. Ha già ricevuto uno studio che racchiude una classificazione completa delle automazioni e tecnologie innovative ritenute prioritarie dal progetto AutoSUP in termini di maturità, impatti, sostenibilità suddivise tra le seguenti categorie, che servirà come base per le discussioni:</p> <ul style="list-style-type: none"> • Modalità di trasporto: automazioni per il trasporto stradale, ferroviario, aereo e marittimo. • Hub e magazzini: con attenzione a terminal di carico e magazzini intelligenti. • Flussi informativi e gestione del traffico merci elettronico. • Automazione della supply chain come network integrato. <p>Il workshop segue un primo incontro svoltosi ad Anversa, che ha delineato gli obiettivi dell'automazione nel trasporto merci multimodale e nella logistica. A Trieste, proseguiamo questo lavoro con un focus sulle priorità italiane, per arricchire e approfondire la visione comune e per presentare l'azione pilota del Living-Hub di Trieste. Il programma prevede discussioni sullo stato attuale delle tecnologie di automazione, identificazione di barriere, esigenze e requisiti per l'implementazione lungo la supply chain logistica e esplorazione di opportunità e sfide.</p> <p>Non sono richieste presentazioni, ma un contributo attivo, specialmente durante le sessioni interattive, esplicitando il proprio punto di vista.</p>



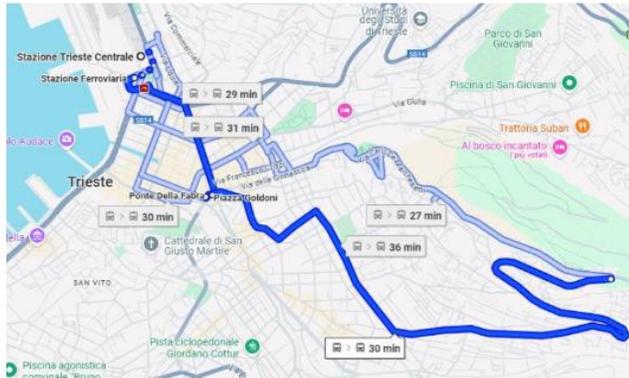
Agenda

10th December 2024

#	Activity Detail	Start Time	End Time	Speaker
1	Introductions and goals of the workshop	10:30	10:50	Maurizio Cociancich and Giuseppe Luppino
2	Tour de table, intro of the participants	10:50	11:05	all
3	Introduction to multimodal freight transport and logistics automation	11:05	11:25	Ioanna Fergadiotou and Ilias Gkotsis
4	Classification of automations	11:25	11:40	Marco Mazzarino
5	Use case scenario definitions	11:40	11:55	Luca Lucietti
6	Coffee break	11:55	12:10	
7	Goals for the Trieste use cases, with insights from Adriafer and Gruber Logistics.	12:10	12:55	Adriafer and Gruber Logistics. Moderation from Luca Lucietti"
8	Key note presentation	12:55	13:15	
9	Lunch	13:15	14:05	
10	Key note presentation	14:05	14:25	
11	Introduction to the second part of the workshop	14:25	14:35	Giuseppe Luppino
12	Session on Interoperability and technological integration	14:35	15:05	Moderated by Giuseppe Luppino
13	Session on Impact of automation on personnel	15:05	15:35	Moderated by Giuseppe Luppino
14	Coffee break	15:35	16:05	
15	Session on Legal aspects, security, and cybersecurity	16:05	16:35	Moderated by Giuseppe Luppino
16	Session on Costs and benefits of automation	16:35	17:05	Moderated by Giuseppe Luppino
17	Session on Collaboration among supply chain actors	17:05	17:35	Moderated by Giuseppe Luppino
18	Closure of the meeting	17:35	17:50	
19	End of the meeting	17:50	17:50	

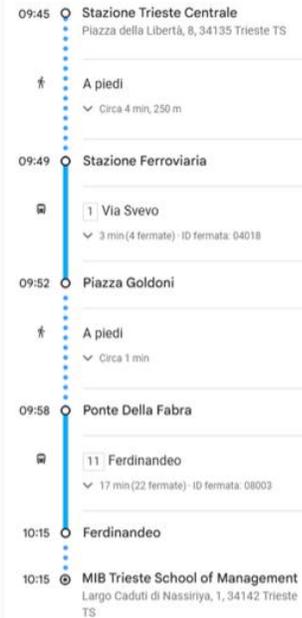


Annex I – how to reach the meeting venue



Link to Google maps:

<https://maps.app.goo.gl/M7WQihSDYoySbkuz7>



GB English GB	IT Italiano IT
<ol style="list-style-type: none"> Trasporto pubblico: Se arrivi alla Stazione Trieste Centrale, puoi prendere l'autobus numero 1 in direzione Via Svevo. Scendi alla fermata Piazza Goldoni e cambia con l'autobus numero 11 diretto al Ferdinando. Arrivato al capolinea, ti troverai proprio di fronte al MIB. Taxi:In alternativa, dalla Stazione Trieste Centrale puoi prendere un taxi che ti porterà direttamente al MIB. Il costo stimato per questa tratta è di circa 15€. 	<ol style="list-style-type: none"> Public transportation: If you arrive at Trieste Centrale Station, take bus number 1 heading to Via Svevo. Get off at Piazza Goldoni, then switch to bus number 11 towards Ferdinando. Once at the final stop, you'll find yourself right in front of the MIB. Taxi: Alternatively, you can take a taxi from Trieste Centrale Station directly to the MIB. The estimated cost for the ride is approximately 15€.





Workshop in Trieste Agenda



Annex II – online meeting connection details

We highly encourage in-person participation in this workshop, as it fosters more meaningful and concrete interactions, essential for identifying needs and gaps.

If you are unable to attend in person and wish to participate online, please find the connection details below.

Microsoft Teams [Need help?](#)

[Join the meeting now](#)

Meeting ID: 386 431 541 18

Passcode: FH6DL3Tm

For organisers: [Meeting options](#)





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Annex III - Questionnaire to the experts

Made with [EUSurvey](#)



AUTOSUP D1.2 questionnaire guidance

Fields marked with * are mandatory.

1 Introduction



Introduction of the project

1



We are pleased to invite you to participate in a semi-structured interview as part of the AUTOSUP (AUTonomous Multimodal SUPply Chains) project, funded by the Horizon Europe programme. The project aims to define the requirements for seamless automation in multimodal freight transport by addressing the technical, operational, social, and digital aspects of automation technologies.

AUTOSUP gathers automation requirements and integrates innovative technologies into an open, ready-to-use data-driven Decision Support System (DSS). This system is designed to empower transport and logistics stakeholders to conduct feasibility analyses and support the investment and implementation of cutting-edge automation solutions. New operational, governance, and organizational change management models support these efforts.

The Ports of Antwerp-Bruges and Trieste will serve as 'Living Hubs,' validating automation solutions through six diverse use cases that encompass both existing and new modes of transport.

We warmly invite you to become a member of the AUTOSUP Stakeholder Community and actively contribute to shaping the future of logistics automation.

This questionnaire serves as a discussion guide for semi-structured interviews. The aim is not to answer all questions, but to provide a framework for meaningful discussions. Interviewers will adapt the questions based on the interviewee's expertise and role

Join the AutoSUP stakeholder forum

The AutoSup Stakeholder Community is a network of experts, industry leaders, and researchers collaborating on the AutoSup Project, which focuses on advancing automated supply chains in the automotive sector. The community facilitates knowledge exchange, innovation, and partnerships to enhance supply chain resilience and sustainability. Members gain access to events, discussions, and cutting-edge insights on automation trends.

To join this stakeholder forum please go to

<https://www.autosup-project.eu/stakeholder-community/>

How You Can Engage and Benefit

By joining the [ALICE Automation community](#), you'll have the opportunity to:

- **Participate in Workshops and Strategic Consultations:** Collaborate with experts to refine insights and address gaps in logistics automation.
- **Contribute to Surveys and Interviews:** Help shape a comprehensive understanding of the industry's needs and challenges.
- **Experience Living Lab Demonstrations:** Provide feedback and contribute to lessons learned on advanced solutions tested at key hubs like Antwerp-Bruges and Trieste.
- **Join Technical Working Groups:** Define standards and frameworks for the future of multimodal freight transport.
- **Access to examples, use cases and best practices** implemented developed in the framework of research projects or local activities

Need More Information?

Visit the AUTOSUP website www.autosup-project.eu and feel free to contact us with any questions:

- [Giuseppe Luppino](#)
- [Tomasz Dowgielewicz](#)



- [Nik Delmeire](#)

What has been done until now

As part of the AUTOSUP project, two stakeholder workshops were conducted in Antwerp and Trieste, bringing together local and project-internal stakeholders. The objective of these sessions was to identify key requirements and challenges related to logistics automation across several thematic areas. These workshops provided a first step in structuring the discussion on how automation impacts multimodal logistics, offering valuable insights that will be further explored in this interview.

During our discussion, we will cover the following key topics:

- Interoperability – Challenges and requirements for integrating automation into logistics systems across nodes and corridors.
- Human-Machine Interaction (HMI) – The role of automation in workforce adaptation, training, and human-machine collaboration.
- Cybersecurity and Legal Aspects – Ensuring security, compliance, and risk management in automated logistics operations.
- Defining Requirements and Roadmap – Prioritizing essential requirements and structuring an automation implementation roadmap.
- Feasibility and Investment Analysis – Identifying financial and strategic drivers for automation adoption.
- Environmental and Sustainability Factors – Examining how automation can contribute to greener and more sustainable logistics.

* 1.1 The questionnaire was...

- directly done by the expert
- done through an interview from AutoSUP

1.1 Information on the interviewer

1.1.1 Organization name

1.1.2 Interviewer name

1.1.3 Email

1.2 information about the interviewee

1.2.1 Organization name



1.2.2 Expert name

1.2.3 Email

* 1.2.4 Type of expert

- Logistics operator (e.g.: Terminal operator, shipper, technology provider)
- Association, Network, policy organization
- Research Center or innovation hub

2 Introduction and Context

Notes for the interviewer

- The purpose of this section is to understand the interviewee's perspective on automation in logistics and gather insights on their role, experience, and expectations. Given that we are engaging with a diverse set of stakeholders—including logistics operators, industry associations, research centers, and policy networks—the questions are designed to be flexible and applicable to different backgrounds.
- Stakeholder Role in Automation For logistics operators:
 - Insights into their current level of automation, implemented technologies, and challenges they face in integrating automation into their operations.
 - For associations, networks, or research centers: Understanding of how they support, analyze, or influence automation in logistics (e.g., through research, advocacy, regulatory discussions, or project facilitation).
- Perception of Automation in Logistics
 - Broader views on the current state of automation adoption in logistics.
 - Trends observed across different sectors or regions.
 - Identification of key barriers and enablers for automation in logistics.
- Key Drivers and Business Value of Automation
 - Why organizations are investing in automation (cost savings, efficiency, regulatory compliance, competitiveness, sustainability).
 - What stakeholders expect in terms of business value or return on investment (ROI).
 - Which areas need the most attention to ensure smooth adoption of automation.
- How Interviewees Should Approach This Section:
 - This section is not meant to be technical but rather to frame their involvement and perspective on logistics automation.
 - If they do not directly implement automation, they can describe how they support, analyze, or engage with automation-related topics.
 - The ranking question allows them to express priorities and expectations regarding automation.

2.1 Can you describe your role and your organization's involvement in logistics and automation? (If you are a logistics operator, describe your experience with automation in your operations. If you are a research center, association, or network, describe how you engage with automation, whether through studies, advocacy, or facilitating adoption.)



2.2 What is your perspective on the current level of automation in logistics? (What trends do you observe? Is the adoption of automation increasing in your sector? What are the key drivers or barriers?)

2.3 How does your organization interact with automation in logistics?

- For logistics companies: What aspects of automation have you implemented or are you planning to implement?
- For research centers and associations: What topics related to automation are you currently working on? Are there specific areas where you are supporting companies or stakeholders in their transition to automation?

2.4 What do you see as the most significant opportunities or challenges related to automation in the logistics sector?

2.5 What are the key factors driving automation in logistics, and what business value do you expect from it? Why automation is an opportunity? (Please rank from 1 = most important to 5 = least important)

Use drag&drop or the up/down buttons to change the order or accept the initial order.

⋮ Efficiency & cost reduction (e.g., reducing labor costs, optimizing processes)

⋮ Workforce adaptation & training (e.g., upskilling employees, addressing resistance to change)

⋮ Cybersecurity & data protection (e.g., securing automated systems, managing risks).Regulatory & legal frameworks (e.g., compliance with policies, liability issues)

⋮ Customer service & market competitiveness (e.g., faster deliveries, improved tracking and traceability)



3 Interoperability

Objective: Collect input on requirements to improve integration across logistics nodes and corridors, with a specific focus on automation-related interoperability challenges. This section aims to explore not just data exchange and collaboration, but also how automation integrates into different systems and nodes—ensuring the discussion is directly relevant to logistics automation.

Lesson learned from the two workshops

The Antwerp and Trieste workshops highlighted key challenges and opportunities related to interoperability in logistics automation, with a focus on integrating legacy systems, data exchange, and the need for standardized communication across stakeholders and geographies.

- System Integration and Data Interoperability:
 - A major challenge in automation is the lack of interoperability between different logistics platforms, including Terminal Operating Systems (TOS), Port Community Systems (PCS), and customs platforms.
 - Stakeholders emphasized that system integration must be addressed holistically, rather than solving individual technical issues in isolation.
- Standardization and Data Exchange:
 - The absence of universal standards for data exchange between logistics hubs, transport operators, and automated systems was widely discussed.
 - In Antwerp, stakeholders stressed the importance of neutral organizations like ALICE and DTLF in fostering cross-sector standardization.
 - In Trieste, discussions pointed to the need for international communication standards, particularly for countries operating across different regulatory and digital environments (e.g., Italy-Turkey logistics).
- Automation in Freight Hubs and Ports:
 - Ports have more developed digital systems (PCS), whereas freight hubs lack similar platforms, leading to data fragmentation.
 - Stakeholders proposed creating a federation of freight hubs to unify data under a common platform, ensuring seamless integration across logistics nodes.
- Business and Competitive Factors:
 - Some stakeholders, such as Interporto Padova, have developed proprietary software solutions, which raise questions about open data accessibility vs. commercial interests in interoperability.
 - Financial and regulatory incentives for data sharing were identified as key drivers for improving system-wide integration.

Interoperability remains one of the most significant barriers to seamless automation in logistics. The discussions from both workshops emphasized that standardization, data sharing, and cross-border compatibility are critical enablers for automation success. Future efforts should focus on developing common platforms, regulatory incentives, and collaboration mechanisms to drive a more integrated logistics ecosystem.

3.1 All type of stakeholders



3.1.1 What are the main challenges in integrating automation into existing logistics systems and nodes? (e.g., compatibility between automated processes, data synchronization, or coordination between manual and automated systems)

3.1.2 What specific measures or practices could improve the interoperability of automated logistics systems? (e.g., standard data formats, improved software/hardware compatibility, integration of automated equipment like AGVs or robotics with legacy systems)

3.1.3 From your perspective, what are the biggest operational bottlenecks caused by automation integration, and how do they impact efficiency or decision-making?

3.1.4 How important is the role of transparency and data sharing in achieving seamless automation integration? What could encourage stakeholders to adopt more open data-sharing practices?

3.2 For logistics operators (e.g., terminal operators, shippers, technology providers)

3.2.1 What factors contributed to its success?

3.2.2 What challenges did you face, and how did you overcome them?



3.2.3 What specific measures or practises could improve collaboration between stakeholders (e.g. customs, terminal operators, IT providers) to enhance integration

3.2.4 What are the main challenges your company faces when integrating automated systems across logistics nodes and corridors?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- Lack of data sharing between stakeholders
- Incompatibility between automated and legacy systems
- Limited technical expertise or training within organizations
- Resistance to adopting automation (e.g., concerns over cost or complexity)
- Absence of standardized automation processes or protocols
- Hardware limitations in integrating automated equipment across different environments

3.2.5 Which of the following measures would most improve the interoperability of automated logistics operations?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- Developing shared platforms for automation data exchange and coordination
- Providing training and capacity building on automation integration
- Promoting collaboration through neutral organizations or partnerships in the EU
- Offering financial incentives or funding for automation integration projects
- Investing in standardization efforts for automation compatibility across logistics nodes

3.2.6 What incentives would encourage your company to invest in automation-ready data-sharing platforms? (e.g., regulatory compliance, cost reduction, competitive advantage, faster adoption of automation solutions, funding opportunities, etc.)



3.2.7 Can you share any examples of successful integration initiatives or approaches that could serve as a model for improving interoperability in the logistics automation? What factors contributed to its success?

3.3 For associations, networks, and policy organizations

3.3.1 From the perspective of your members or stakeholders, what are the biggest obstacles to automation integration in logistics?

3.3.2 Do they relate more to technology, business models, or regulatory issues?

3.3.3 What role do you see for your organization in supporting automation interoperability?

3.3.4 Do you facilitate...

- knowledge sharing
- advocate for policy changes
- provide technical guidance
- Other



3.3.5 Other facilitations

3.3.6 What kind of collaborative frameworks or funding mechanisms could best support interoperability in automation?

- Horizon Europe
- Interreg
- national funding
- regional funding
- Others?

3.3.7 collaborative frameworks or funding

3.4 For research centers and innovation hubs

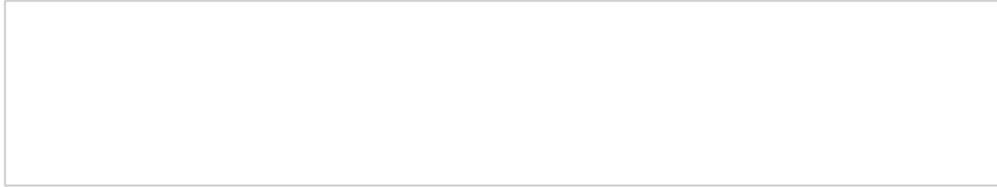
3.4.1 What are the most promising technological solutions you have identified for improving automation interoperability in logistics?

3.4.2 Are there emerging trends, such as AI-driven logistics or blockchain for data sharing, that you think will shape the future of interoperability?

3.4.3 What gaps still exist in research regarding interoperability of automated systems in logistics?

3.4.4 What role should academia and research centers play in supporting industry-wide adoption of automation integration practices?





4 Human-Machine Interaction (HMI)

Objective: This section aims to understand the training and operational requirements for effective Human-Machine Interaction (HMI) in logistics automation, focusing specifically on how humans interact with automated systems.

Lesson learned from the two workshops

The Antwerp and Trieste workshops explored the impact of automation on logistics personnel, focusing on required skills, workforce adaptation, and operational safety. Stakeholders discussed how automation is reshaping job roles, the need for new training approaches, and strategies for overcoming resistance to change.

- Skill Evolution and Workforce Training:
 - Logistics automation is shifting roles from execution-based tasks to skill-based responsibilities, requiring IT expertise, problem-solving, and remote operations management.
 - Coding skills and control center operations are becoming increasingly important.
 - Some stakeholders suggested that gamers and IT professionals with logistics knowledge could be a new recruitment target.
 - The importance of staggered training programs was highlighted, ensuring workers gradually adapt to new technologies.
- Impact on Work and Workforce Resistance:
 - While automation can reduce workforce shortages and improve work-life balance, stakeholders noted that it can also create stress and job insecurity due to the transition from field jobs to office-based remote operations.
 - Resistance to automation is particularly strong in labor-intensive sectors, such as port operations, where unions play a significant role in shaping workforce policies.
- Training, Change Management, and Awareness Strategies:
 - Stakeholders emphasized the importance of coaching, process management, and feedback systems to support workers transitioning to automated environments.
 - Pilot projects and demonstrators can help workers understand how automation benefits them, reducing fears of job loss.
 - Communication strategies should be tailored for different stakeholders, from policymakers to frontline workers, ensuring clear messaging on the benefits and implications of automation.
- Safety and Remote Operations:
 - Automation technologies such as exoskeletons, robots, and cobots are already being implemented in warehouses to support human workers, not replace them.
 - The Padova freight terminal is transitioning to remote-controlled cranes, which will be fully automated in the coming years. This shift improves worker safety by reducing exposure to hazardous conditions.



Automation in logistics is not just about replacing human labor but transforming the way humans interact with automated systems. Training, awareness, and change management are critical to ensuring a smooth transition for workers, while safety and remote operations will play a key role in shaping the future of automated logistics.

4.1 For all stakeholders

4.1.1 What requirements should human-machine interfaces (HMI) meet to ensure safe, efficient, and intuitive interaction between humans and automated systems? (Focus on ease of use, adaptability, real-time feedback, and monitoring capabilities)

4.1.2 In your experience, are there any specific cultural or workforce challenges (e.g. lack of skills, resistance to change) that hinder HMI adoption? (E.g., lack of technical skills, resistance to change, concerns about job security)

4.1.3 What strategies have you found effective in managing resistance to HMI adoption? (E.g., change management strategies, awareness campaigns, customized training, stakeholder engagement)

4.1.4 What risks do you associate with human-machine interaction in logistics automation?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- ⋮ Lack of proper monitoring and control of automated systems
- ⋮ Safety concerns (e.g., increased risk of accidents due to over-reliance on automation).
- ⋮ Cybersecurity vulnerabilities in HMI platforms
- ⋮ Difficulties in adapting existing workflows to automation-enhanced environments



4.2 For logistics operators (e.g., terminal operators, technology providers, transport companies)

4.2.1 What specific safety and security measures should be implemented in logistics environments where humans and automation interact?

(E.g. safety protocols, emergency override mechanisms, cybersecurity layers in HMI systems)

4.2.2 How does your company train personnel to effectively use, monitor, and intervene in automated systems when needed?

(E.g. simulation training, real-world testing, structured certification programs)

4.2.3 What operational changes do you see as necessary to optimize work environments where humans and automated systems coexist?

(E.g. redesigning workflows, implementing monitoring tools, redefining responsibilities)

4.3 For associations, networks, and policy organizations

4.3.1 What are the biggest challenges your members/stakeholders report in adopting HMI solutions in logistics automation?

(E.g. need for better guidelines, policy gaps, lack of investment in workforce training.)



4.3.2 What role should policy and standardization play in ensuring safe and effective HMI adoption in logistics?
(E.g., guidelines for human oversight of automation, safety regulations for semi-autonomous systems.)

4.3.3 What initiatives or programs could facilitate knowledge-sharing and best practices for HMI adoption in the logistics sector?
(E.g. industry working groups, cross-sector collaborations, regulatory advocacy)

4.4 For research centers and innovation hubs

4.4.1 What emerging technologies could improve human-machine interaction in logistics automation?
(E.g. AI-powered decision support, augmented reality interfaces, wearable tech for automation control.)

4.4.2 What research gaps still exist regarding HMI and the integration of humans in automated logistics environments?

5 Cybersecurity and legal aspects

Objective: This section aims to define the cybersecurity and legal requirements needed to ensure the security, compliance, and resilience of automated logistics systems. Given the importance of 24/7 operations, this section also considers contingency planning beyond cybersecurity, addressing broader risks affecting logistics automation.

Lesson learned from the two workshops

The Antwerp and Trieste workshops explored the challenges and requirements for cybersecurity, legal frameworks, and data protection in logistics automation. Stakeholders highlighted data security concerns,



the need for certification standards, and the role of contingency planning in ensuring system resilience. Discussions also focused on vulnerabilities in automated vehicles and autonomous logistics operations, emphasizing the need for harmonized regulations and security strategies.

- Data Security and Confidentiality:
 - Shippers remain hesitant to share data due to confidentiality concerns, competitiveness risks, and potential container theft.
 - Stakeholders raised issues related to ownership, storage, and access control of logistics data, particularly in cloud-based systems, which introduce new cybersecurity vulnerabilities.
 - Trieste, concerns were raised about data handling when managed outside the EU, such as with platforms based in USA or China.
- Cybersecurity Risks in Automated Systems:
 - Automated and interconnected vehicles are prone to cyber-attacks such as spoofing, tampering, and data manipulation.
 - The risk of tracking automated trucks and vessels raises concerns about operational security and potential targeting for attacks.
 - The lack of clear cybersecurity standards and certification requirements for automated logistics systems was identified as a major gap.
 - In Padova, the use of autonomous drones for security monitoring was presented as a case study of AI-driven anomaly detection in logistics operations
- Regulatory Challenges and Certification Needs:
 - The lack of a unified EU regulatory framework for autonomous vehicles and vessels creates uncertainty about liability in case of accidents.
 - Stakeholders asked:
 - Who is responsible for an accident involving an automated truck—the infrastructure operator, the remote operator, or the system provider?
 - Stakeholders advocated for a holistic certification process for integrated automation systems, rather than certifying each technology in isolation.
 - Training for regulators and certifiers was identified as a key priority to ensure proper oversight and understanding of cybersecurity vulnerabilities.
- Security Measures and Strategies:
 - Organizations have already implemented various security measures, including biometric access control, VPNs, network slicing, and user authentication protocols.
 - Additional measures proposed include:
 - Penetration testing and “friendly attacks” to evaluate system resilience.
 - Private 5G networks for secure communications.
 - Cloud repositories for backup and fail-safe systems to prevent disruptions.
 - Intrusion Detection Systems (IDS) to monitor data flow when multiple organizations share platforms.
- Contingency Planning and System Resilience:
 - A fully automated supply chain increases the risk of a single point of failure, making contingency planning essential.
 - Backup strategies discussed included: De-connected (isolated) backup systems to ensure redundancy.
 - Manual override capabilities for automated control systems in case of disruptions.
 - The need for structured insurance processes to cover data breaches and system failures.



Cybersecurity and regulatory frameworks are critical enablers for the safe and reliable adoption of automation in logistics. Stakeholders emphasized the importance of clear data protection policies, harmonized EU regulations, and robust cybersecurity strategies to protect automated systems. Certification of automation technologies and contingency planning will be essential for ensuring resilience and trust in automated logistics operations.

5.1 For all stakeholders

5.1.1 What are the main cybersecurity risks related to automation in logistics operations?

(E.g., data breaches, vulnerabilities in automated decision-making, hacking risks in connected vehicles or warehouse systems)

5.1.2 Who should be responsible for ensuring the cybersecurity of automated logistics systems? (Select all that apply)

- The technology provider or system supplier (must guarantee compliance with cybersecurity standards).
- The logistics operator (LSPs, terminal operators, etc.) (must implement cybersecurity protocols and risk management).
- Industry regulators or certification bodies (should define clear security standards).
- A shared responsibility model (suppliers provide secure solutions, but operators ensure implementation and monitoring).
- Other?

5.1.3 If other

5.1.4 What cybersecurity requirements should be prioritized to ensure the security and operational continuity of logistics automation? *(E.g., network security, real-time threat detection, security updates, employee training)*

5.1.5 How should automated logistics systems be designed to ensure resilience in 24/7 operations?

(e.g., backup systems, manual override, disaster recovery protocols)



5.1.6 Which of the following risks associated with automation integration do you consider most critical for logistics operations?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- ⋮ Low quality or incomplete external data causing operational disruptions
- ⋮ Increased vulnerabilities from interconnected systems
- ⋮ Loss of competitive advantage due to data sharing
- ⋮ Lack of clarity in legal responsibilities for system failures

5.2 For cybersecurity experts (Optional, to be answered only if relevant to the interviewee)

5.2.1 Which cybersecurity measures should be prioritized to enhance the protection of automated logistics systems?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- ⋮ Implementation of advanced security protocols (e.g., VPN, two-factor authentication).
- ⋮ Regular penetration testing and risk assessments.
- ⋮ Training programs to raise awareness and skills in cybersecurity
- ⋮ Developing industry standards for data sharing and protection
- ⋮ Promoting collaboration between stakeholders to address shared risks

5.2.2 Should certification be required for automated logistics systems to ensure cybersecurity compliance?

(Yes/No, with justification)

5.3 For logistics operators (LSPs, terminal operators, warehouse managers)

5.3.1 What are the key legal or regulatory challenges that limit the adoption of automated systems in logistics?

(E.g., GDPR, liability in case of accidents involving automated vehicles, lack of guidelines for cross-border data management)



5.3.2 If you purchase and implement an automated system from a supplier, how do you manage cybersecurity risks?

- We fully rely on the supplier's security compliance and certification.
- We conduct additional cybersecurity assessments before implementation.
- We collaborate with third-party cybersecurity providers to secure our systems.
- We follow industry best practices but do not have a structured cybersecurity strategy.
- Other

5.3.3 If other

5.3.4 What security-related contractual requirements should be in place when acquiring automated logistics technologies?

(e.g., liability clauses, incident response plans, cybersecurity guarantees)

5.4 For associations, networks, and policy organizations

5.4.1 What policy or regulatory actions could help improve cybersecurity and legal clarity for automated logistics systems?

(E.g., clearer liability rules, cybersecurity certification standards, harmonization of EU laws)

5.4.2 What initiatives could facilitate best practices and collaboration on cybersecurity among logistics stakeholders?

(E.g., working groups, regulatory harmonization, industry standards.)



6 Conclusions

6.1 Defining Requirements and Roadmap

Objective: This section aims to identify the key requirements necessary for accelerating automation in logistics and define priorities for a roadmap. It focuses on both technical and regulatory aspects while ensuring that responses are tailored to the interviewee’s specific experience with automation.

6.1.1 What requirements do you consider essential to accelerate the implementation of automation in logistics nodes and corridors?

(If your organization is actively involved in automation, what are the key enablers needed? If not, what factors do you see as essential from your perspective?)

6.1.2 What legal or regulatory barriers have you encountered when implementing automation, or what challenges do you foresee in broader adoption?

(E.g., not clear liability rules, lack of standards, cross-border regulatory misalignment, certification requirements)

6.1.3 If you had to prioritize three fundamental requirements for multimodal automation, which ones would you choose?

Use drag&drop or the up/down buttons to change the order or accept the initial order.

- Technical integration and system compatibility
(e.g., interoperability between automation systems, connectivity between platforms).
- Workforce training and adaptation
(e.g., new skills for human-machine collaboration, transition from manual to automated processes).
- Cybersecurity and data protection (e.g., secure data exchange, risk mitigation strategies). Regulatory and compliance frameworks
(e.g., liability in case of failures, GDPR, cross-border harmonization).
- Business models and investment incentives
(e.g., funding schemes, return on investment, operational cost reductions).

6.2 Feasibility and Investment Analysis



Objective: This section aims to identify financial and strategic factors that influence automation adoption in logistics. It seeks to understand which funding models, incentives, and business benefits drive investment in automation across different stakeholders

6.2.1 What funding models or support would make automation investments more viable for your company?
(E.g. government grants, tax incentives, public-private partnerships, access to EU programs like Horizon Europe, Interreg, or regional operational programs)

6.2.2 What are the main drivers for you to consider automation? What specific benefits would motivate you to prioritize automation investments in your logistics operations?

6.3 Environmental and Sustainability Factors

Objective: This section focuses on how logistics automation contributes to environmental sustainability while identifying key barriers and enablers for adopting greener automated solutions. The goal is to understand both the practical and regulatory aspects of sustainable automation in logistics operations.

6.3.1 How do you see automation contributing to the reduction of greenhouse gas emissions in your operations?

6.3.2 Are there any legal or operational barriers to adopting greener automated solutions?

6.4 Conclusions



Objective: This section provides a final opportunity for interviewees to share additional insights that may not have been covered in previous sections. It also aims to gauge their interest in continuing engagement with the AUTOSUP project.

6.4.1 Do you have any additional suggestions or requirements that you believe are important for the success of multimodal automation? (E.g. aspects not covered in previous sections, missing stakeholder perspectives, or additional challenges that should be addressed)

6.4.2 Single Choice Question

- Yes
- No

Would you like to participate to the ALICE community on logistics automation? If yes we need you to register on <https://forms.office.com/e/iJ53KzYA80>





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