



# 5G LOGINNOV

## **Deliverable 4.4**

### **Lessons learned and recommendations for stakeholders**

[www.5g-loginnov.eu](http://www.5g-loginnov.eu)



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## List of abbreviations and acronyms

Abbreviation	Meaning
<b>4G/5G</b>	4 <sup>th</sup> /5 <sup>th</sup> Generation (of cellular networks)
<b>AI</b>	Artificial Intelligence
<b>CPU</b>	Central processing unit
<b>EC</b>	European Commission
<b>GPUs</b>	Graphics Processing Units
<b>HMI</b>	Human-Machine Interface
<b>ICT</b>	Information and Communication Technology
<b>IPR</b>	Intellectual Property Rights
<b>IT</b>	Information Technology
<b>ITS</b>	Intelligent Transportation Systems
<b>IoT</b>	Internet of things
<b>KPI</b>	Key Performance Indicator
<b>LL</b>	Living Lab
<b>R1, R2, R3...</b>	Recommendation 1, Recommendation 2, Recommendation 3...
<b>PPPs</b>	Public-Private Partnerships
<b>SLA</b>	Service Level Agreements
<b>SME</b>	Small-Medium Enterprise
<b>TRL</b>	Technology Readiness Level
<b>WBS</b>	Work Breakdown Structure
<b>WP</b>	Work Package



## EXECUTIVE SUMMARY

Deliverable D4.4 Lessons learned and recommendations for stakeholders is a strong guide for policymakers and stakeholders to enhance the proliferation and transferability of innovations developed under the 5G-LOGINNOV project. These innovations, as well as the project and this document aim to support the further deployment of 5G technologies.

There are a number of significant policies already in place that enable and/or support the deployment of these type of technologies, however there is still room for improvement. This deliverable offers an overview of those policies and identifies EU policies that the recommendations developed could complement.

The project focused on supporting the emergence of a European offer for new 5G core technologies. The after-project aim is to ensure that these technologies can be transferred over to as many ports as possible within the EU and the lessons learned disseminated. Therefore, it is essential to understand the impact and the potential of these technologies/innovations and lessons. To achieve this task, it was crucial to identify the most relevant innovations/outputs of the project that are key to support the further deployment of 5G technologies. It was also important to locate these project outputs towards the relevant roadmaps that are shaping the future of 5G. Therefore, this document presents the most relevant outputs of the project, as well as the relevant roadmaps, as identified by the project partners through several technical workshops. Another exercise carried out during the workshops was the realization of 2 policy frameworks within the recommendations derived. The first policy framework is to ensure priority roll out of 5G networks on EU hinterland network and port area; the second one is to enhance research, development and deployment of AI applications to support most optimal Logistic supply chain and port operation.

The document also reveals the problems that the living labs encountered to realise these innovations, identifying the various issues that needed to be addressed to enhance the projects objectives of transferability. The gaps identified during the deployment, under each policy framework, were grouped in categories and presented to external stakeholders in a series of workshops and interviews to collaboratively kick-start the development of recommendations. In addition, the deliverable reveals an in-depth analysis on the needed recommendations, 64 in total.

The recommendations under the first policy framework (ensure priority roll out of 5G networks on EU hinterland network and port area) address technical issues like compatibility with existing systems, availability of specialized equipment, and cybersecurity concerns. They also tackle infrastructure and cost barriers by ensuring port structures support 5G and reduce equipment costs through subsidies. Regulatory challenges involving diverse local regulations and privacy concerns are also addressed. The goal is to streamline these areas for a more successful implementation of 5G in EU ports. The recommendations also include addressing administrative difficulties by harmonizing city-specific requirements and standardizing technical interfaces. In addition, they also tackle training and expertise gaps by proposing specialized education and knowledge-sharing initiatives. Furthermore, they address issues with business models by suggesting dedicated funds, public-private partnerships, and regulatory support. The goal is to ensure a smoother 5G implementation in critical transport and logistics sectors.

On the other hand, the recommendations under the second policy (enhance research, development and deployment of AI applications to support most optimal Logistic supply chain and port operation) focus on solutions like investing in AI tools, traffic management protocols, and efficient data handling. The recommendations also focus on standardization and collaborations with equipment manufacturers. In addition, it is recommended to involve legislative bodies to align AI operations with legal frameworks. These solutions span from investing in R&D to data exchange protocols for traffic as well as encouraging hardware improvements, and policy collaborations. Furthermore, this second policy framework offers recommendations for streamlining administrative tasks, providing extensive training resources, and developing innovative business models that prioritize return on investment (ROI). The suggestions aim to foster expertise, collaboration, and transparency in handling administrative, training, and financial aspects, aligning them with the project's logistical and port operation objectives.

On the final sections of the deliverable and for both policy frameworks, an exhaustive list of recommendations can be found with the stakeholders they are addressed to. The stakeholder list

includes public authorities (local, regional and national), policy makers (member states and EU level), industry (shippers, transport companies (carriers) and forwarders, terminal and hub operators and technology providers), telecommunication operators (operators and suppliers), research and universities, and standardization organizations.

Finally, strategies are proposed to deploy innovations, enhance transferability, and address recommendations for stakeholders in the logistics industry. These recommendations target policy frameworks to prioritize 5G networks and advance AI applications, aligning with EU policies. The approach involves forming ROI studies, developing digital twin models for port operations, and engaging various stakeholders—policy makers, industry, and research entities—to foster collaborative agreements and standards. The goal is to support the efficient deployment of technology across the logistics landscape in Europe.





# 1 INTRODUCTION

## 1.1 Project intro

5G-LOGINNOV will focus on seven 5G-PPP Thematics to support the emergence of a European offer for new 5G core technologies in 11 cluster of use cases. 5G-LOGINNOV's main aim is to design an innovative framework addressing integration and validation of Connected Automated Driving/Mobility (CAD/CAM) technologies related to the industry 4.0 and port domains by creating new opportunities for LOGistics value chain INNOVation. 5G-LOGINNOV is supported by 5G technological blocks, including new generation of 5G terminals notably for future Connected and Automated Mobility, new types of Industrial Internet of Things 5G devices, data analytics, next generation traffic management and emerging 5G network architectures, for city ports to handle upcoming and future capacity, traffic, efficiency, and environmental challenges. 5G-LOGINNOV will deploy and trial 11 families of use cases targeting beyond TRL7, including a GREEN TRUCK INITIATIVE using CAD/CAM & automatic trucks platooning based on 5G technological blocks. Thanks to the new advanced capabilities of 5G relating to wireless connectivity and core network agility, 5G-LOGINNOV ports will not only significantly optimise their operations but also minimise their environmental footprint to the city and the disturbance to the local population. 5G-LOGINNOV will be a catalyst for market opportunities build on 5G core technologies in the logistics and port operations domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SMEs and start-ups. 5G-LOGINNOV will open SMEs' and start-ups' door to these new markets using its three Living Labs as facilitators and ambassadors for innovation in future European ports. 5G-LOGINNOV's promising innovations are key for the major deep-sea European ports in view of the mega-vessel era (Athens, Hamburg), and are also relevant for medium sized ports with limited investment funds (Koper) for 5G.

## 1.2 Purpose of the deliverable

The purpose of this deliverable is to provide recommendations to key stakeholders, including public authorities and policymakers, to support the emergence of a European offer for new 5G core technologies enhancing next generation logistics hubs and ports in Europe and beyond. This document will consider roadmaps for sustainable logistics and proposes a complementary focus on the potential of 5G core technologies innovations. The recommendations will provide a framework based on 5G-LOGINNOV.

## 1.3 Intended audience

This deliverable is public and therefore any stakeholder interested in the lessons learned from the 5G-LOGINNOV project can make use of it. It is specifically addressed to the identified stakeholders in Section 6 of the document.

## 1.4 Structure of the deliverable and its relation with other work packages/deliverables

This deliverable is the primary source of information for the projects recommendations and lessons learned. The document is structured as follows:

- Section 2 provides the methodology followed to develop the lessons learned and recommendations.
- Section 3 presents a literature review and identified relevant EU policies.
- Section 4 describes the recommendations, lessons learnt from the project.
- Section 5 presents the deployment options for the recommendations as well as provides a list of identified stakeholders to whom it is addressed.

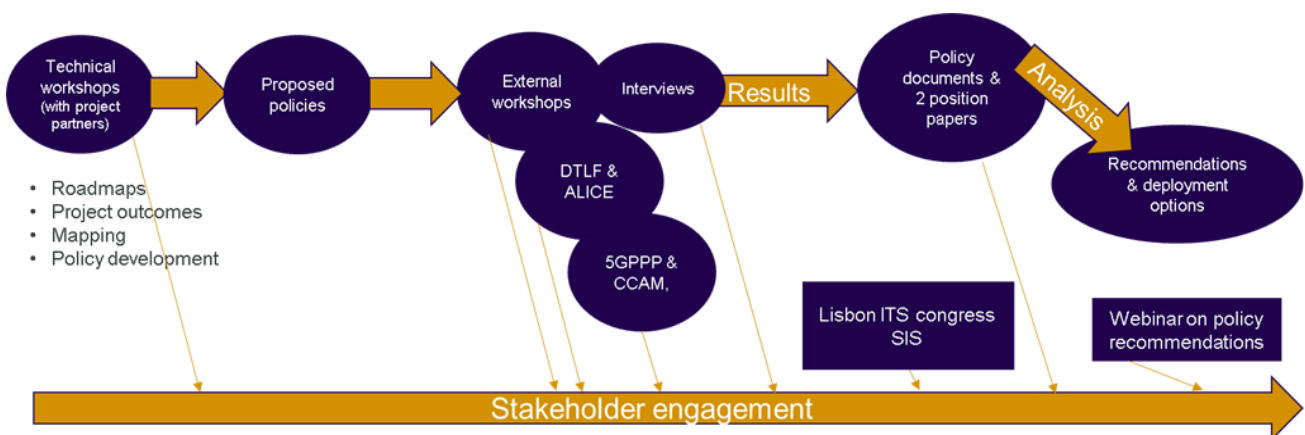
In Annex 1 and 2, the internal workshop outputs can be found. Annex 3 provides the interview questions created for the collection of additional inputs from stakeholders. And finally, in Annex 4 and 5, the interview notes can be found.

This deliverable is strongly connected with other project activities, specifically:

- The testing of the innovations in the living labs (WP3) as the base of the gaps and issues encountered.
- WP5 T5.5 – Clustering and Networking as it is crucial to share the lessons learnt from the project to the relevant stakeholders.

## 1.5 Summary of actions

To accomplish the efficient development of the lessons learned and recommendations included in this document a detailed plan was elaborated, a summary of that plan can be found below.



**Figure 1:** Summary of actions taken to develop the lessons learnt and recommendations

The first step taken to develop the lessons learnt and the policy recommendations was to organize several technical workshops with the project partners. Subsequently the policies and issues identified that could hinder the deployment of 5G technologies were shared and open to discussion with external stakeholders. Two external workshops and interviews with identified stakeholders were arranged, more specifically with: the 5G Infrastructure Public Private Partnership (5G PPP), the European Partnership on Connected, Cooperative and Automated Mobility (CCAM), the Digital Transport and Logistics Forum (DTLF) and the Alliance for Logistics Innovation through Collaboration in Europe (ALICE). The final actions focused on the dissemination of the lessons learnt through an on-line webinar, a Special Interest Session at the ITS European Congress in Lisbon and 2 position papers.



## 2 METHODOLOGY

This section describes the methodology followed to elaborate the policy recommendations that can be found in section 4.

### 2.1 Identification and collection of relevant roadmaps

Firstly, relevant roadmaps were identified, roadmaps that the outcomes and lessons learned of the project could potentially contribute to. The roadmaps identified can be found below:

Organization	Roadmap	Source
<b>5G PPP</b>	5G Trials Roadmap	<a href="https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf">https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf</a>
<b>ALICE</b>	Roadmap to the Physical Internet	<a href="https://www.etp-logistics.eu/wp-content/uploads/2020/11/Roadmap-to-Physical-Internet-Executive-Version_Final.pdf">https://www.etp-logistics.eu/wp-content/uploads/2020/11/Roadmap-to-Physical-Internet-Executive-Version_Final.pdf</a>
<b>CCAM</b>	ERTRAC Roadmap	<a href="https://www.ertrac.org/news/new-ccam-roadmap-for-public-consultation/">https://www.ertrac.org/news/new-ccam-roadmap-for-public-consultation/</a>
<b>ERTICO</b>	Connected Cooperative & Automated Mobility Roadmap	<a href="https://ertico.com/focus-areas/connected-automated-driving/">https://ertico.com/focus-areas/connected-automated-driving/</a>
	Transport & Logistics Roadmap	<a href="https://ertico.com/focus-areas/transport-logistics/">https://ertico.com/focus-areas/transport-logistics/</a>
	Clean & Eco-Mobility Roadmap	<a href="https://ertico.com/focus-areas/clean-mobility/">https://ertico.com/focus-areas/clean-mobility/</a>
<b>Other relevant roadmaps identified</b>		
<b>5GAA</b>	Roadmap for Automotive connectivity	<a href="https://5gaa.org/news/the-new-c-v2x-roadmap-for-automotive-connectivity/">https://5gaa.org/news/the-new-c-v2x-roadmap-for-automotive-connectivity/</a>
<b>ACEA</b>	Roadmap for the Deployment of Automated Driving in the European Union	<a href="https://www.acea.auto/publication/roadmap-for-the-deployment-of-automated-driving-in-the-european-union/">https://www.acea.auto/publication/roadmap-for-the-deployment-of-automated-driving-in-the-european-union/</a>
<b>ALICE</b>	Roadmap Towards Zero Emissions Logistics 2050	<a href="https://www.etp-logistics.eu/wp-content/uploads/2019/12/Alice-Zero-Emissions-Logistics-2050-Roadmap-WEB.pdf">https://www.etp-logistics.eu/wp-content/uploads/2019/12/Alice-Zero-Emissions-Logistics-2050-Roadmap-WEB.pdf</a>
<b>European Commission</b>	Sustainable and Smart Mobility Strategy	<a href="https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf">https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf</a>

**Table 1:** List of roadmaps identified

### 2.2 Identification and collection of relevant 5G-LOGINNOV outputs

Together with the project partners, relevant outputs from the project were identified. A selection of the most relevant outcomes that could potentially contribute to the roadmaps identified on the previous section was made.

Main Deliverables		
5G enabled AI for supporting logistic processes	Protecting Vulnerable Road users	Coordination external and internal truck
Green light speed advice (impact mainly for platoon)	Tailored public 5G network in port	Security surveillance video streaming...
Remote telemetry monitoring	Private stand-alone 5G network	Container seal protection (Validates the content of the container)
Collision avoidance system (Between truck and people)	Predictive maintenance	Video facilitating hand over of container between external and port internal trucks
Industrial grade 5G Gateway to connect sensors, cameras...	Wearable camera and drones	Impact traffic management - Increase speed - less CO2
Precise positioning	Fixed cameras (AI supported)	

**Table 2:** Main outputs of 5G-LOGINNOV relevant to the roadmaps identified

A detailed description of the main outcomes from the project can be found in *D5.4 Exploitation Plan* and *D5.5 Exploitation report*.



## 2.3 Establishment of a common vision on main Policy Needs

This section presents the methodology followed to identify the policy needs, resulting in 2 policy frameworks.

### 2.3.1 Report on internal workshops (project partners)

Several technical workshops were organized with the project partners (from November 2022 to March 2023). These internal workshops were meticulously designed to immerse project partners in a comprehensive exploration of the gaps within 5G-LOGINNOV's endeavour to support the emergence of a European offer for new 5G core technologies. These insights, in turn, served as the bedrock for formulating cohesive and unified recommendations tailored for public authorities and the EU Commission.

The aim of the workshops was to identify which outputs of the project could potentially support the roadmaps identified. To accomplish this objective, project partners were presented with a list of outputs, collected from the previously mentioned deliverable (D5.4), where they selected the most relevant ones.

The conclusions that were drawn from the internal workshops were that the innovation (output of the project) that contributes the most to the roadmaps identified is:

#### ***5G enabled AI for supporting logistic processes***

Other innovations that scored high were:

- Green light speed advice
- Collision avoidance
- Remote telemonitoring

In addition, the roadmap that was identified as the most relevant one because most of the project outputs could potentially contribute to is:

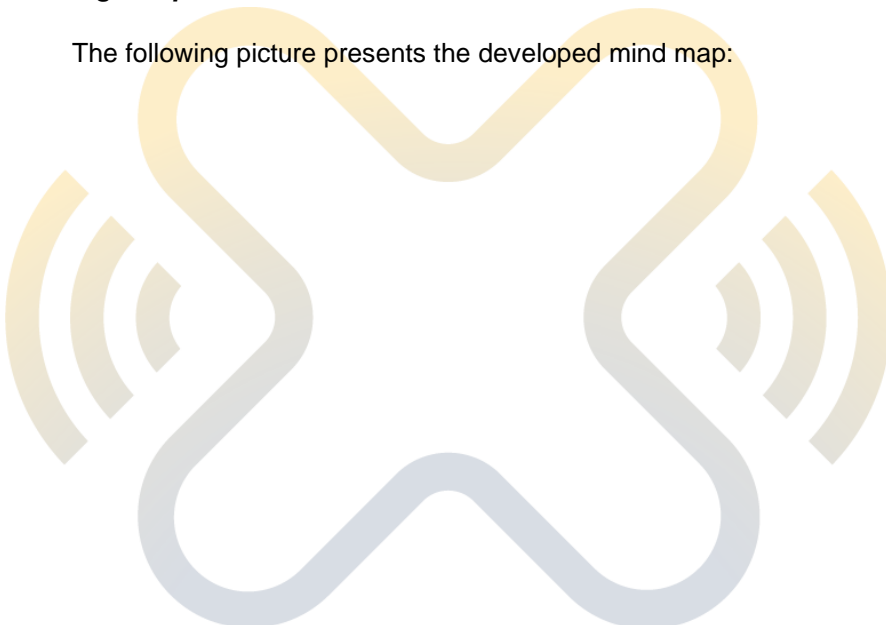
#### ***ERTICO Logistics roadmap 2025: Full digitalisation and automation of T&L (Transport & Logistics), interoperability on trusted data exchange in T&L***

An exhaustive list of outputs and roadmaps can be found in the Annex 1.

Based on the most relevant innovation selected by the partners, *5G enabled AI for supporting logistic processes*, a top-level mind map (see figure below) was developed to derive 2 top policy frameworks/statements that set up the foundation of the recommendations and lessons learned.

What topics can be mapped/identified in relation to the innovation: ***5G enabled AI for supporting logistic processes?***

The following picture presents the developed mind map:



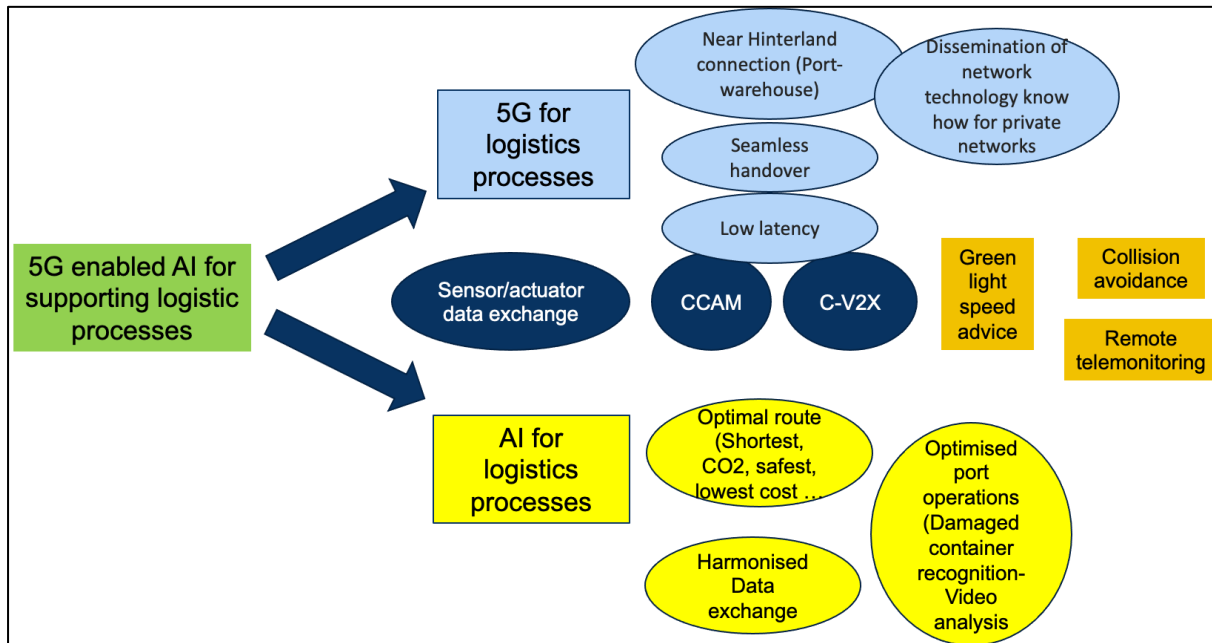


Figure 2: Top level mind map

Considering the most relevant output as a base, the partners identified other related innovations. After, the consortium identified general, top-level policy needs to further develop and maintain this 5G enabling innovations in the future. In conclusion, 2 policy frameworks/statements were formulated. The following image presents the derived policy frameworks.

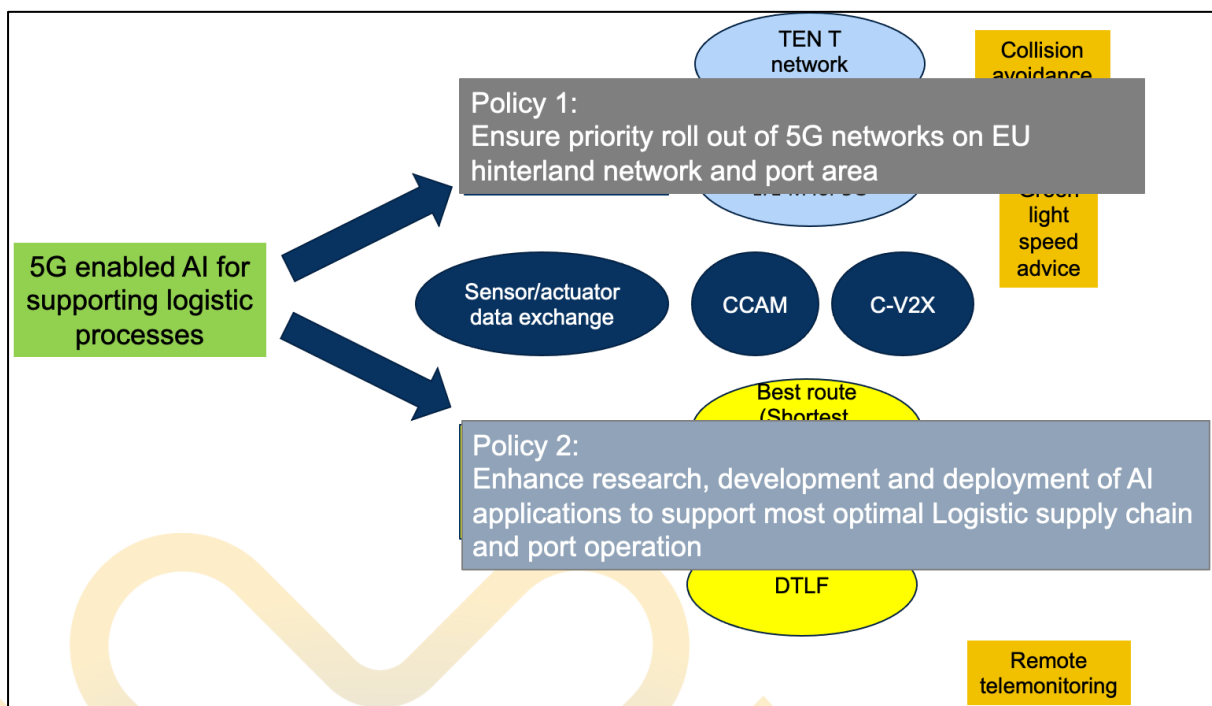


Figure 3: Top level policy statements

In summary, the first policy framework/statement is to “Ensure the priority roll out of 5G networks on EU hinterland network and port area”.

And the second policy framework/statement is to “*Enhance research, development, and deployment of AI applications to support most optimal Logistic supply chain and port operation*”.

These two policy frameworks are relevant as they contribute to the efficiency, safety, security, and sustainability in port operations and around the port transport and mobility. Furthermore, they support the 'Industry 5.0' pillars:

- Resiliency (e.g. in ports Koper, and in Hamburg in the port hinterland).
- Human centricity: monitoring and improving - safety and security of work force and transport drivers/ road users-work conditions.
- Sustainability: Contribute to the CO2 reduction.

In alignment with the two policies a systematic approach was established to identify impediments to their implementation. To achieve this, distinct categories were formulated, inspired by the issues and roadblocks encountered by partners during the project's deployment in the 3 living labs around Europe.

The categories developed with a short description are:

- **Technical gaps:** These encompassed technical problems such as inadequate electricity connections and compatibility issues with legacy infrastructure.
- **Infrastructure and Installation gaps:** Problems arising from the lack of compatibility with legacy infrastructure were examined.
- **Regulatory gaps:** Including instances where installation and operation didn't align with existing laws, requiring approvals, or dealing with legislative gaps and unclear rules.
- **Administrative issues:** Administrative concerns included the need for certificates, registrations, and compliance tests.
- **Training and Expertise:** This addressed challenges related to the shortage of technical personnel to install equipment and difficulties in understanding its operation.
- **Business Models:** This included observations of resistance from customers or entrepreneurs regarding investment in the project, possibly due to unclear business models.

In the process of establishing a common vision on main policy needs and to support the partners in identifying the issues, a comprehensive questionnaire was prepared. Three questions were created:

- What challenges did you encounter when implementing the project solutions in the hinterland network and port area?
- Are 5G operators interested in supporting the 5G-LOGINNOV use cases, or do they show limited attention?
- How can the project enhance capacity building for 5G equipment?

The inputs from the partners to the questionnaire can be found in Annex 2.

The answers to the questionnaire supported the development of the lessons learnt and policy recommendations that can be found in the next section (section 4).

### 2.3.2 Contribution towards zero emissions logistics roadmap in 2050.

In line with one of the projects objectives (Objective 3), it was relevant to consider the contribution the 5G-LOGINNOV innovations have towards zero emission logistics.

The International Transport Forum (ITF) estimates that international trade-related freight transport currently accounts for around 30% of all transport related CO2 emissions from fuel combustion, and more than 7% of global emissions<sup>1</sup>. As mentioned, Objective 3 aims to significantly reduce ports and logistics hubs operation emissions (CO2/NOX) and regulate the resulting freight traffic on the future 5G

<sup>1</sup> International Transport Forum. (n.d.). The Carbon Footprint of Global Trade: Tackling Emissions from International Freight Transport. <https://www.itf-oecd.org/sites/default/files/docs/cop-pdf-06.pdf>

logistics corridor in EU, including CAM truck platooning management. A question was raised towards the partners regarding possible calculations or project results that could support the objective in the ports (living labs).

The Athens port had some difficulties to estimate emission reduction due to alternative routes or other means. Besides the transport itself, the partners identified the following innovations having the most potential to contribute to the objective:

- Green light speed advice
- Optimal routing

For both innovations, the living labs reported on the following questions:

- How can you deploy/implement these innovations?
- Are there results from the project?

Two of the Living Labs, Hamburg and Athens, responded to the questions. The Living Lab in Koper did not test these two specific innovations linked to this objective. The answers can be found in the figure below:

Innovations	Questions	Hamburg	Athens
<b>Green light speed advice</b>	Implementation?	Roadmap will be defined by local authorities	
	Any results from the project?	Beginning with TAVF equipped with extended traffic lights, Hamburg will rollout additional 100 traffic lights in the next years. Overall number of traffic lights not discussed so far > 1600	
<b>Optimal route to reducing emissions</b>	Implementation?	Include live emissions data to route planning as navigation layer. Plus, use of historical data needed.	Using real-time traffic and congestion data alternative are suggested to reduce cost/emission.
	Any results from the project?	Much more data needed, increased sensing of traffic and objects related needed. Current sensors are not enough, there is a need to think beyond 5G sensing!	Within the area of the port not many alternative routes exist, not enough data exist to support it.

**Table 3:** Contributions to zero emissions in 2050

### 2.3.3 Report on external workshops (5G-PPP, CCAM, DTLF & ALICE)

The 2 workshops revolved around the two policy frameworks developed and presented in the previous section and focused on identifying solutions to the gaps identified.



- **External workshop with 5G-PPP - ERTICO office – Brussels.** On March 29<sup>th</sup> 2023, a workshop was convened by ERTICO, gathering various representatives from living labs, as well as external delegates from the 5G Infrastructure Public Private Partnership (5G PPP). The session extended for approximately two hours and aimed to garner insights from the 5G-PPP standpoint regarding the deployment gaps identified by 5G-LOGINNOV. The primary objective was to collaboratively formulate shared recommendations targeted at public authorities and the EU Commission, with the goal of enhancing potential transferability and deployment.
- **External workshop with CCAM and DTLF - ERTICO office – Brussels.** On May 31<sup>st</sup> 2023, a workshop was organised by ERTICO, bringing together a diverse group of participants. This included representatives from various living labs, external members affiliated with the Digital Transport and Logistics Forum (DTLF), The Alliance for Logistic Innovation and Collaboration in Europe (ALICE), as well as experts from European Partnership on Connected, Cooperative and Automated Mobility (CCAM). The session, which lasted approximately 2 hours, focused on collecting insights from external participants concerning the identified deployment gaps within the scope of 5G-LOGINNOV. The central aim was to foster collaborative efforts in generating recommendations for both public authorities and the EU Commission, all geared towards enhancing the applicability and implementation of these research findings.

### 2.3.4 Report on interviews (ALICE & CCAM)

In addition to the workshops, 2 interviews were organized with key stakeholders to gather additional inputs. The interviews were conducted with one representative of ALICE and one from the CCAM partnership.

The two representatives were presented with the issues identified during the deployment of the 5G solutions to contrast with the gaps they have gathered from previous experiences on related projects. In addition, they were also consulted on possible ways to tackle the roadblock identified. The inputs gathered in the interviews have been aggregated with the ones gathered during the workshops.

A summary of the interviews can be found in Annex 4 and 5.

## 3 LITERATURE REVIEW AND CURRENT POLICIES

In recent years, the European Union (EU) has taken significant steps to advance the deployment of 5G technology and promote its integration with various sectors, including logistics and transportation. Two key initiatives in this regard are the 5G Action Plan<sup>2</sup> and the EU Electronic Communications Code<sup>3</sup>.

The **5G Action Plan**, initiated in 2016, was a pivotal step by the European Commission with the overarching goal of making 5G technology accessible throughout the EU by the close of 2020. This comprehensive plan revolved around several key objectives, including the establishment of a synchronized timeline for 5G rollout, allocation of spectrum bands, and the cultivation of collaboration among member states. The plan's emphasis on fostering a unified approach to 5G deployment set the stage for coordinated efforts across the EU.

In 2018, the EU introduced the **EU Electronic Communications Code**, further bolstering the groundwork for 5G infrastructure. This legislative measure was designed to facilitate the deployment of 5G infrastructure by implementing regulatory provisions aimed at streamlining administrative processes and approvals for the deployment of small cells. Additionally, it encouraged investments in high-capacity networks to support the burgeoning 5G ecosystem.

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<sup>2</sup> <https://digital-strategy.ec.europa.eu/en/policies/5g-action-plan#:~:text=The%205G%20Action%20Plan%20is,and%20businesses%20across%20the%20EU.&text=Very%20high%20capacity%20networks%20like,225%20billion%20annually%20by%202025.>

<sup>3</sup> <https://digital-strategy.ec.europa.eu/en/policies/eu-electronic-communications-code>

Additionally, the **Regulation (EU) 2020/1056, enacted on 15 July 2020**<sup>4</sup>, marks a significant milestone in the regulation of electronic freight transport information (eFTI) within Europe. This regulation focuses on enabling the digitalization of freight transport by establishing a robust framework for the electronic exchange of information pertaining to goods transported across EU borders. It delineates rules and standards for electronic freight transport documents, encompassing vital components such as electronic waybills, thus enhancing the efficiency and sustainability of cross-border logistics.

In parallel, the **Artificial Intelligence Act**<sup>5</sup> represents a momentous stride in European policy, even though its primary focus extends beyond freight transport. This legislative act introduces harmonized regulations governing the utilization of artificial intelligence across various sectors, including logistics and transportation. Its core objective is to ensure the safety, transparency, and ethical adherence of AI systems deployed within Europe. To achieve this, the AI Act outlines comprehensive requirements for AI developers and users, covering facets like data handling, transparency, and risk assessment. These stipulations are pivotal for the responsible integration of AI technologies within the realm of logistics and supply chain management, promoting both safety and operational efficiency.

In conclusion, these strategic European initiatives, including the 5G Action Plan and the EU Electronic Communications Code, converge with Regulation (EU) 2020/1056 and the Artificial Intelligence Act, collectively laying the groundwork for the seamless integration of 5G core technologies into logistics hubs and ports. Furthermore, they form an integral part of the broader EU strategy aimed at fostering a digital single market, enhancing logistics operations, and promoting innovation in emerging technologies such as 5G.

## 3.1 Identified 5G related EU policies

The European Union had taken several actions and implemented policies related to 5G networks and technology. Below is an overview of some key 5G-related EU policies up to date.

### 3.1.1 5G relevant EU policies

A list of policies related to or that have an impact on 5G have been identified.

1. **5G Action Plan:** In 2016, the European Commission launched the 5G Action Plan, which aimed to make 5G technology available across the EU by the end of 2020. The plan focused on creating a common timeline for 5G deployment, allocating spectrum bands, and fostering cooperation between member states to ensure a unified approach to 5G rollout.
2. **Spectrum Allocation and Harmonization:** The EU took measures to harmonize the allocation of spectrum for 5G services across its member states. This harmonization aimed to promote efficient use of frequencies, facilitate cross-border connectivity, and ensure interoperability between 5G networks in different EU countries.
3. **Cybersecurity in 5G Networks:** The EU established measures to address security concerns related to 5G infrastructure. This included guidelines for member states to conduct risk assessments of 5G networks, assess the supply chain of vendors, and apply security measures to protect critical infrastructure from potential cyber threats.
4. **EU Electronic Communications Code:** In 2018, the EU adopted the Electronic Communications Code, which introduced regulatory measures to support the deployment of 5G infrastructure. The code aimed to reduce administrative barriers, simplify approval processes for deploying small cells, and promote investment in high-capacity networks.
5. **5G Public-Private Partnership (PPP):** The EU engaged in a Public-Private Partnership for 5G infrastructure to encourage collaboration between industry stakeholders and public institutions.

<sup>4</sup> <https://european-accreditation.org/new-regulation-eu-2020-1056-on-electronic-freight-transport-information-has-been-published/#:~:text=The%20aim%20of%20the%20new,efficiency%20and%20sustainability%20of%20transport.>

<sup>5</sup> [https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698792/EPRS\\_BRI\(2021\)698792\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698792/EPRS_BRI(2021)698792_EN.pdf)

The PPP sought to boost research, development, and innovation in 5G technologies, as well as accelerate the commercialization and adoption of 5G networks and services.

- 6. Digital Single Market Strategy:** Although not exclusively focused on 5G, the Digital Single Market Strategy was a broader initiative aiming to harmonize digital policies across the EU. A unified digital market would facilitate the deployment and adoption of 5G services, applications, and digital products.
- 7. Horizon 2020:** The EU's research and innovation program, Horizon 2020, supported several 5G-related projects aimed at developing new technologies, use cases, and business models. This initiative played a crucial role in fostering innovation and advancements in the 5G ecosystem.

### 3.1.2 EU policies on EU hinterland network and port area

The European Union (EU) has several policies related to the development of port areas and their hinterland. These policies aim to enhance the efficiency, sustainability, and competitiveness of European ports while promoting economic growth and regional development. An overview of some key EU policies on this topic can be found below.

- 1. Trans-European Transport Network (TEN-T):** The TEN-T policy is a major EU infrastructure initiative designed to improve the connectivity and integration of transport networks across Europe. It includes the development of key ports and their hinterland as part of its strategic goals. TEN-T projects often focus on improving the accessibility and efficiency of ports, enhancing rail and road connections to inland areas, and facilitating multimodal transport solutions.
- 2. Connecting Europe Facility (CEF):** CEF is a financial instrument that supports infrastructure development in the fields of transport, energy, and digital services. Within the transport sector, the CEF provides funding for projects that enhance port infrastructure and improve the connectivity between ports and their hinterland. This funding is crucial for the implementation of large-scale port development projects.
- 3. Urban Agenda for the EU - Port Areas:** The Urban Agenda for the EU is an initiative that aims to address the specific challenges and opportunities of urban areas, including port cities. Under the Port Areas partnership, EU member states, cities, and stakeholders collaborate to develop integrated and sustainable strategies for port areas and their hinterland, focusing on issues like transport, environment, and urban development.
- 4. EU State Aid Guidelines for Maritime Transport:** The EU's State Aid Guidelines for Maritime Transport outline the conditions under which financial support to ports and shipping companies can be considered compatible with EU competition rules. This helps create a level playing field for European ports and ensures that public funding is used to foster sustainable development and not distort competition.
- 5. European Maritime Single Window:** The European Maritime Single Window Environment is a regulation that aims to streamline and simplify administrative procedures for shipping and port activities. It facilitates the electronic exchange of information between ships and ports, improving the efficiency and competitiveness of port operations and the hinterland's logistics.
- 6. Green Deal and Sustainable Ports:** The EU's Green Deal is a comprehensive plan to make Europe climate-neutral by 2050. It includes initiatives to promote sustainability in various sectors, including transport and ports. Sustainable Ports initiatives aim to reduce greenhouse gas emissions, promote energy efficiency, and integrate renewable energy solutions in port areas and their hinterland.

## 3.2 Identified AI related EU policies

Some actions had already been taken and implemented by the EU bodies related to Artificial Intelligence (AI). Below is an overview of some key AI EU policies up to date.

### 3.2.1 AI related EU policies

The following list is identified:

1. **Ethics Guidelines for Trustworthy AI:** The EU published guidelines on the ethical aspects of AI in April 2019. These guidelines emphasize principles such as transparency, accountability, fairness, and the protection of fundamental rights. They aim to ensure that AI technologies are developed and used in a manner that aligns with EU values.
2. **AI Strategy:** The EU adopted a comprehensive AI strategy in April 2018. This strategy outlines the EU's vision for AI development and its potential to drive economic growth while addressing societal challenges.
3. **High-Level Expert Group on AI:** The EU established a High-Level Expert Group on AI (AI HLEG) to provide position recommendations and guidance on AI-related matters. This group included experts from various fields and stakeholders.
4. **AI Act:** This legislative act introduces harmonized regulations governing the utilization of artificial intelligence across various sectors, including logistics and transportation. Its core objective is to ensure the safety, transparency, and ethical adherence of AI systems deployed within Europe. To achieve this, the AI Act outlines comprehensive requirements for AI developers and users, covering facets like data handling, transparency, and risk assessment.
5. **Data Strategy:** The EU's Data Strategy, announced in February 2020, complements its AI strategy. It seeks to facilitate access to data while ensuring its responsible and secure use, which is essential for AI development.
6. **Digital Services Act (DSA) and Digital Markets Act (DMA):** While not exclusively focused on AI, these proposed regulations aim to address issues related to online platforms and digital services, which can also impact AI applications and data sharing.
7. **Investment in AI Research:** The EU has allocated significant funding for AI research and development through programs such as Horizon 2020 and Horizon Europe. These programs support AI innovation and projects across various sectors.
8. **International Cooperation:** The EU has been actively engaged in international discussions on AI governance and is working to promote a global approach to AI ethics and regulation.
9. **AI in Specific Sectors:** The EU has also developed policies and initiatives focusing on the use of AI in specific sectors like healthcare, transportation, and agriculture, addressing sector-specific challenges and opportunities.

### 3.2.2 EU policies on optimal Logistic supply chain and port operation

Furthermore, policies and initiatives to ensure an optimal logistic supply chain and port operation have been identified. Some of them already mentioned previously like the Trans-European Transport Network (TEN-T), and European Green Deal.

1. **Customs and Trade Facilitation:** The EU has policies and initiatives focused on streamlining customs procedures and trade facilitation to reduce delays and administrative burdens for goods entering and leaving the EU. This includes the use of electronic customs declarations and risk management systems.
2. **Green Logistics and Sustainable Ports:** The EU promotes sustainable logistics and port operations through various policies and initiatives. These efforts include reducing emissions

from transport, promoting energy-efficient logistics, and supporting the development of eco-friendly ports.

3. **Digitalization and Interconnectivity:** The EU encourages the digitalization of logistics and port operations to improve efficiency and transparency. Initiatives such as the Digital Transport and Logistics Forum (DTLF) aim to promote digital solutions and interoperability in the transport and logistics sector.
4. **Investment in Transport Infrastructure:** The EU provides funding through programs like the Connecting Europe Facility (CEF) to support infrastructure projects that improve transport and logistics networks, including ports and intermodal terminals.
5. **Security and Safety Measures:** The EU has policies in place to ensure the security and safety of goods and passengers in the transport sector, including port operations. These measures are designed to protect against security threats and ensure the smooth flow of trade.

As seen above, there are some policies already in place that address the topics, policy frameworks and issue that arose during the project. The work carried out to develop the recommendations that can be found on section 5 of this deliverable has taken all these policies into consideration and offer a complimentary approach to tackle the issues/gaps.



## 4 RECOMENDATIONS AND LESSONS LEARNED

On this section recommendations developed with the 5G-LOGINNOV partners and external stakeholders mentioned above will be presented as lessons learned from the project. The section will be divided in the two policy frameworks developed and presented in Section 3 (more specifically in section 3.3.1).

### 4.1 Policy Framework 1: Ensure priority roll out of 5G networks on EU hinterland network and port area

5G-LOGINNOV developed several 5G related innovations in 3 different living labs. During the realisation of these innovations, roadblocks or gaps were detected that prevent early deployment, scalability, and further efficiency in the ports. These gaps related to the policy framework “5G networks on EU hinterland network and port area” are listed and 32 related recommendations are phrased to overcome them and further enhance transferability of the innovations across Europe. The recommendations are listed under the categories identified and presented in section 3.3.1, which are: Technical gaps, Infrastructure and Installation gaps, Regulatory gaps, Administrative issues, Training and Expertise and Business Models.

#### 4.1.1 Technical gaps

Under the technical gaps category, some challenges were identified, and recommendations (R) developed.

##### 1. Ensure Legacy infrastructure compatibility and data availability

To facilitate 5G integration a cohesive and standardized approach is necessary. It is also essential to address the technical gaps, while ensuring compatibility with legacy infrastructure and promote data availability. To achieve this, the following recommendations are proposed:

###### **R1 Implement the OCIT Standard Data Protocol for Equipment<sup>6</sup> Across EU Ports**

Encourage and support the adoption of the OCIT (Open Connectivity Interface for Road Traffic Telematics) standard data protocol for all 5G equipment deployed in ports across the European Union. By promoting the OCIT standard, which has been successfully used for traffic data in Germany, a uniform and interoperable data communication framework will be established. This will enable seamless data exchange and compatibility among various 5G-enabled equipment and systems, improving overall efficiency and performance in port operations.

###### **R2 Encourage Cities to Collaborate on a Common Data Interface for Legacy Standards**

Encourage cities and port authorities to collaborate on developing a common data interface. This interface should aim to bridge the divide between 5G technologies and existing legacy standards, promoting a harmonized approach to data exchange and sharing. Through collaborative efforts, cities can pool their expertise and resources to create a unified solution that enhances data availability and accessibility.

###### **R3 Ensure Longevity of Traffic Information Equipment and Support Certified Suppliers**

To promote sustainable 5G integration in ports, prioritize measures to ensure the long life of traffic information equipment. This will involve encouraging the use of durable and future-proof technologies, enabling seamless upgrades and adaptability to evolve standards. Additionally, support an open market of certified suppliers, akin to the French model, to foster healthy competition and innovation. By providing certification for suppliers meeting quality and compatibility standards, the government will instill confidence in the market, leading to more reliable and standardized equipment.

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<sup>6</sup> Open Communication Interface for Road Traffic Control Systems (OCIT): Rules and Protocols [https://www.ocit.org/media/ocit-o\\_protokoll\\_v2.0\\_a04\\_en.pdf](https://www.ocit.org/media/ocit-o_protokoll_v2.0_a04_en.pdf)

#### **R4 Legacy infrastructure**

The Legacy infrastructure equipment often has a significantly long lifespan, which poses challenges when considering technological upgrades. The longevity of these systems means that organizations must carefully plan and allocate resources for transitioning to newer technologies while ensuring uninterrupted operations.

These recommendations aim to create an ecosystem where 5G innovations can seamlessly integrate with legacy infrastructure, overcoming technical barriers and ensuring data availability. Through the adoption of standard data protocols, collaborative efforts to establish common data interfaces, and support for reliable suppliers, the way is paved for efficient and effective 5G implementation in ports across the European Union.

### **2. Overcome the lack of Chipset & Industrial grade equipment availability**

During the development and deployment of the innovations, the lack of availability of industrial grade equipment was a major issue in the project timeline and introduced a lot of risks to the project. The stakeholders formulated the following position recommendations:

#### **R5 Strengthening the IoT Market for Industrial-Grade Equipment and Solutions**

Strengthening the IoT market's capabilities in providing industrial-grade equipment and solutions tailored for 5G deployment in ports. This will involve targeted initiatives and investments to promote research and development in the IoT sector, with a specific focus on creating robust and reliable equipment suitable for industrial applications.

#### **R6 Establish industry-wide guidelines and standards for industrial-grade 5G equipment and components**

By promoting interoperability and compatibility, these standards will create a level playing field for equipment manufacturers, encouraging healthy competition and ensuring high-quality products for the market.

#### **R7 Enhancing collaboration with industry stakeholders, research institutions, and technology providers**

Enhancing collaboration with industry stakeholders, research institutions, and technology providers to identify key areas where innovation is needed. Public-private partnerships, facilitate knowledge sharing and resource pooling, enabling the development of cutting-edge solutions that meet the unique requirements of 5G implementation in port environments.

#### **R8 Provide financial incentives and support for start-ups and small to medium-sized enterprises (SMEs) in the IoT domain**

These incentives may include grants, tax breaks, or access to venture capital, fostering an ecosystem that nurtures innovation and entrepreneurship. Such support will accelerate the availability of industrial-grade equipment and solutions, reducing the risk associated with project timelines.

These recommendations address the lack of chipset and industrial-grade equipment for 5G deployment in ports by suggesting the strengthening of the IoT market through targeted initiatives, supporting startups and SMEs, promoting industry-wide standards, and fostering international collaboration. An environment can be created where reliable and cutting-edge industrial-grade equipment and solutions are readily available, reducing project risks and accelerating the deployment of 5G in ports.

### **3. Supply chain enhancement (of 5G related equipment, services...)**

Living labs were frequently confronted with the problem to find the relevant suppliers. Equipment can be bought, but then partners need to find the right supplies to bring service to live to this equipment. It is also difficult to find equipment and services that were useable for the port and hinterland 5G - LOGINNOV innovations. This problem area leads to the following recommendations:

### **R9 Address the responsibility of Mobile Network providers to prioritize the Supply Chain Enhancement for 5G-related Equipment and Services**

Mobile network operators should actively engage in enhancing the supply chain for 5G-related equipment and services. This includes promoting collaboration with equipment manufacturers, technology providers, and other stakeholders to ensure a robust and diversified supply chain. The operators should prioritize the use of reliable, secure, and cutting-edge technologies to support the deployment and expansion of 5G networks. Mobile network operators bear the responsibility of deploying and maintaining efficient, secure, and accessible 5G networks. Additionally, operators should work closely with regulatory bodies and other relevant organizations to address any emerging challenges related to 5G deployment and usage.

### **R10 Proactive role in Regulation and Network Coverage**

Regulatory authorities should play a proactive role in demanding the necessary network coverage to achieve comprehensive 5G deployment in ports and their hinterlands. This includes setting clear guidelines and targets for coverage, capacity, and quality of service to ensure that 5G networks benefit ports and their hinterlands.

### **R11 Focus on Transport and Mobility, including Cross-border Connectivity**

The development and integration of 5G networks should consider the transport and mobility sectors, including cross-border connectivity. Mobile network operators should collaborate with relevant transportation authorities to implement 5G-enabled solutions that enhance mobility, logistics, and overall transport efficiency. Emphasis should be given to improving 'near port' hinterland connectivity, while also acknowledging the importance of 'far hinterland' connections, such as the Trans-European Transport Network (TENT) and rail infrastructure.

### **R12 Balancing Focus on Different Sectors**

While acknowledging the importance of maritime connectivity, the focus of 5G initiatives should extend towards ports and hinterland (inland areas close to ports). Efforts should also be made to include the far hinterland, particularly the Trans-European Transport Network (TENT), to ensure a balanced and comprehensive 5G network coverage across the EU. This approach will foster economic development and integration across regions and sectors.

These recommendations aim to guide and promote the deployment, regulation, and utilization of 5G technology in a manner that maximizes its benefits for both the economy and society while ensuring equitable access and coverage in ports and their hinterlands.

## **4. Private networks – assignment of frequency bands**

During the 5G-LOGINNOV innovation developments, it was remarked that the frequency allocation possibilities for 5G private networks in the ports of Koper and Athens was not possible in Germany. Living labs were also confronted with the need to obtain completely new equipment necessary that could cope with these required frequency bands.

Questions were raised if private networks were necessary since 5G supports network slicing. The insight however is that private networks support additional features and have the expectation of respecting more privacy and security resilience.

These experiences and insights lead to the following recommendations:

### **R13 Facilitating Private 5G Networks and Spectrum Assignment**

Recommendation to streamline the process for private entities to establish their own 5G networks by facilitating spectrum assignment. By creating clear and efficient procedures, private organizations will have improved access to the necessary frequency bands to deploy their dedicated 5G networks. This approach aims to promote innovation and customization, allowing private networks to cater to their specific needs.

### **R14 Encourage the implementation of network slicing in 5G networks for Versatility and Efficiency**

Network slicing allows the division of a single physical network infrastructure into multiple virtual networks, each tailored to support different applications and services. By leveraging network slicing, private network operators can efficiently utilize 5G resources and dedicate specific slices to meet their unique requirements.



### **R15 Encourage collaboration between Private Networks and Public Infrastructure**

This approach will enable private networks to leverage the benefits of existing public networks, promoting cost-effectiveness and enhanced connectivity while maximizing the potential of 5G technology.

## **5. Missing position & regulations on cyber security**

Gaps in the current legislation have been assessed, as in most cases regulations cannot keep up with new technologies. This experience leads to the following position recommendations:

### **R16 Addressing the critical issue of missing policies and regulations on cybersecurity in the context of rapidly evolving technologies**

It is vital to implement robust and up-to-date legislation to safeguard against cyber threats and vulnerabilities. Collaboration with relevant stakeholders, including the European Commission's Directorate-General for Communications Networks, Content, and Technology (DG CNECT), is important to develop comprehensive regulations that address cybersecurity concerns in the EU. It is recommended to formulate comprehensive cybersecurity regulations tailored to the specific challenges posed by emerging technologies. These regulations will set stringent standards for the protection of critical infrastructure, sensitive data, and communication networks. The government aims to enhance the overall cybersecurity posture of the EU and ensure the safety and privacy of its citizens and businesses by establishing clear guidelines and requirements.

### **R17 Ensure agility in Legislative Updates**

Recognizing the rapid pace of technological advancements and prioritizing agility in legislative updates related to cybersecurity is vital. This will involve establishing mechanisms to regularly review and adapt regulations to address emerging cyber threats and vulnerabilities. And it will enable the proactive response to potential risks and implement timely and effective solutions by staying abreast of the evolving cybersecurity landscape.

### **R18 Capacity Building and Awareness Initiatives**

To support effective implementation of cybersecurity regulations, invest in capacity building and awareness initiatives. This includes training programs for cybersecurity professionals, educational campaigns for the public on cybersecurity best practices, and promoting a cybersecurity culture within organizations.

These recommendations address the missing policies and regulations on cybersecurity and highlights the relevance of collaborating with DG CNECT and relevant stakeholders, prioritizing agility in legislative updates, fostering public-private collaboration.

## **6. Low latency not guaranteed all the time in commercial networks (Hamburg)**

Especially for the hinterland where 5G-LOGINNOV innovations were connected to the 'commercially available network,' the low latency aspect of the network was not always guaranteed. Therefore, the following recommendations were developed:

### **R19 Ensure reliable and consistent low-latency performance in 5G networks**

To achieve this and optimize latency and establish and meet specified Service Level Agreements (SLAs) it is recommended to work towards resolving license issues with Mobile Network Operators (MNOs) and implementing network slicing features. Collaboration with MNOs to address any license-related issues that hinder the consistent delivery of low latency in commercial networks is also important. This will involve streamlining the regulatory processes to facilitate MNOs in meeting the requirements for low-latency performance. Additionally, actively promoting the adoption of network slicing features, enabling MNOs to allocate specific network resources dedicated to low-latency services is vital. Furthermore, it is important to emphasize low latency as a core specification in the development and deployment of 5G networks. In addition, it is recommended to ensure that 5G services meet the demands of various applications and industries that rely on real-time and highly responsive connectivity. To enhance low-latency performance, developing mobile edge infrastructure, such as local base data hubs, in key regions like Hamburg is needed. These localized data hubs will reduce data transport times and improve overall network responsiveness, addressing latency issues and supporting various latency-sensitive applications.

## **R20 Monitoring and enforcement of SLAs**

To ensure that network providers adhere to the specified low-latency requirements it is necessary to implement a monitoring and enforcement mechanism for SLAs. Through regular audits and performance assessments, the MNOs should be held accountable for meeting their commitments and providing the promised level of low latency to users and businesses.

These recommendations address low-latency challenges in commercial networks. By resolving license issues, promoting network slicing adoption, emphasizing low latency as a core specification, monitoring and enforcing SLAs, and supporting mobile edge infrastructure development, reliable and consistent low-latency performance in 5G networks is guaranteed. This will enhance the overall user experience and support the successful implementation of latency-sensitive applications in various industries.

### **4.1.2 Infrastructure and installation gaps**

Under the infrastructure and installation gaps category, issues were identified, and recommendations (R) developed.

#### **1. Compatibility of port infrastructure to support 5G Hardware components**

During the project, and considering 5G is relatively new in port areas, 5G transponders needed to be installed, the ideal place was on cranes. However, installation possibilities for 5G equipment on cranes is not easy. A potential option is to use the legacy Wi-Fi infrastructure, but this solution is not optimal due to the coverage per transponder. On the other hand, 5G is easier to install because the coverage is greater and it also has other system advantages. 5G allows immediate interactivity with other mobile network clients to enable several feature applications/services.

**R21 Ensure compatibility of port infrastructure** (including equipment like cranes, to support the integration of 5G hardware components)

By facilitating the transition (from legacy Wi-Fi infrastructure) the full potential of 5G technology in the maritime sector enabling improved efficiency, safety, and communication can be unlocked. Working with relevant stakeholders to establish voluntary guidelines and standards for port infrastructure upgrades is recommended. This will encourage private port operators to invest in 5G-compatible equipment and facilitate the deployment of 5G hardware components within port premises. Regarding private network equipment, fostering innovation, and competition in the 5G market is vital.

**R22 Recognise the significant advantages of 5G.**

such as its easier installation process and broader coverage. This technology's capability for immediate interactivity with other mobile network clients opens opportunities for innovative feature applications and services, particularly those designed to enhance safety for vulnerable populations.

These recommendations point to the compatibility of port infrastructure with 5G hardware components, promoting innovation and competition in the 5G market, targeting private network equipment. It leverages the advantages of 5G technology, such as ease of installation, broader coverage, and immediate interactivity to benefit both businesses and the general public.

#### **2. High cost of 5G network equipment**

The project partners were confronted with very high service and equipment cost, sometime 10 times higher than expected and budgeted. There is not (yet) an economy of scale for this type of equipment. The issues identified, lead to the following recommendations:

**R23 Facilitate the deployment of 5G networks by leveraging economies of scale and implementing initial subsidies in strategic sectors such as ports.**

This recommendation is divided in various suggested actions:

- Identify opportunities for cost optimization and encourage technological advancements that may lead to more affordable 5G hardware. Through research and development incentives and partnerships with the private sector, the government should aim to accelerate the development and adoption of cost-effective 5G solutions without compromising on quality and performance.

- Introduce an initial subsidy program targeting key sectors such as ports, airports, and other critical infrastructure. The subsidy will be designed to provide financial support to these entities to offset the higher initial investment required for 5G network deployment.
- Conduct a comprehensive assessment of the benefits that 5G adoption can bring to various sectors within the European Union. This evaluation will consider the potential economic gains, improved efficiency, enhanced safety measures, and innovative services enabled by 5G technology. The subsidy program's scope and scale will be aligned with these identified benefits to maximize the impact of the investment and stimulate economic growth in the region.

**R24 Foster collaboration among public and private partners to establish public-private partnerships (PPPs) that can further enhance the cost-effectiveness of 5G deployment.**

These partnerships (PPPs) will facilitate knowledge sharing, resource pooling, and risk-sharing mechanisms that leverage the strengths of both sectors to drive down costs and accelerate the implementation of 5G networks.

In conclusion, these recommendations address the high cost of 5G network equipment through a multifaceted approach. By leveraging economies of scale, providing initial subsidies, and fostering collaboration between private and public partners, the government aims to accelerate the adoption of 5G technology in critical sectors such as ports and airports, creating a technologically advanced and economically vibrant European Union.

### 4.1.3 Regulatory gaps

Some challenges were identified under this category and the following recommendations were developed.

#### 3. Local authorities are in charge

During the deployment phase of the project, 5G-LOGINNOV partners realized that in most cases local authorities are the ones to oversee e.g., obtaining the necessary deployment agreements. This makes it very difficult for service providers to cope with the amount and variety of procedures from different local authorities, in best case leading to one-to-one agreements. Therefore, there is no central authority in charge. This experience led to the following recommendations:

**R25 Address the existence of regulatory gaps in the deployment and management of 5G networks.**

This recommendation refers to, particularly, the absence of a central authority and the prevalence of one-to-one agreements between local authorities and stakeholders, through collaborative efforts with member states. To bridge the regulatory gaps, it is vital to work closely with member states to establish a cohesive framework that facilitates a harmonized approach to 5G deployment and regulation. This will involve engaging in open dialogues and knowledge-sharing initiatives to understand the unique challenges faced by each member state and develop tailored solutions that align with their respective legal and administrative systems. It is necessary to encourage the establishment of a centralized authority or coordinating body for 5G network management at the regional or national level. This authority will serve as a focal point for coordinating efforts, setting standards, and resolving conflicts that may arise in the implementation of 5G networks. In cases where a centralized authority may not be feasible, it is advisable to promote the establishment of multi-stakeholder forums, bringing together representatives from local authorities, industry players, academia, and relevant experts to collaboratively address regulatory challenges. These forums will facilitate consensus-building and the development of best practices, ensuring that the interests of all stakeholders are considered.

**R26 Facilitate the exchange of best practices and knowledge-sharing between member states**

To learn from successful 5G implementation models and regulatory frameworks it is very important to facilitate the exchange of best practices and knowledge-sharing. This collaborative approach will help identify effective strategies and inspire innovative solutions to overcome

regulatory gaps, leading to a more streamlined and cohesive 5G deployment process. In addition, it is relevant to provide technical assistance and support to address specific challenges in each region. This approach will empower member states to adapt and implement 5G regulations that align with their unique circumstances while ensuring a consistent level of compliance with broader European Union objectives.

#### 4. Privacy issues

Every city has its own data privacy officer, and they decide about the installation requirements such as the necessary cameras for observation. This leads to a variety of conditions that service providers need to deal with. The following recommendations were developed to assist on these situations:

##### **R27 Implementing a streamlined and standardized approach that balances data privacy concerns with the efficient deployment of 5G services.**

This recommendation aims to address the challenges arising from the involvement of data privacy officers in each city, which can hinder communication and coordination with service providers. To ensure the protection of privacy rights while facilitating the deployment of 5G network infrastructure, establishing a clear and comprehensive set of guidelines for camera installation is needed. These guidelines will outline the necessary privacy safeguards, data handling practices, and compliance requirements that must be adhered to during the deployment process. To streamline communication between service providers and local authorities, facilitate the establishment of regional or national coordination bodies. These bodies will serve as a single point of contact for service providers, helping them navigate the diverse requirements of different cities efficiently. This approach will minimize administrative burdens and reduce delays in the deployment of 5G infrastructure. Another action recommended is to promote the use of privacy-enhancing technologies and techniques, such as anonymization and data encryption, to safeguard individual privacy while still allowing for effective use of camera data for legitimate purposes, such as public safety and traffic management. In addition, investing in research and development in privacy-preserving technologies is encouraged to stay at the forefront of data protection practices. Furthermore, it is important to provide educational resources and training to service providers and local authorities on best practices for privacy compliance in 5G deployments. This will promote a shared understanding of privacy requirements and foster a cooperative environment between all stakeholders involved.

#### 4.1.4 Administrative issues

##### 1. Local authorities in charge

Similar to the issue presented in the previous section, it is difficult for service providers to approach every city separately to understand their requirements. The same recommendations apply: R25 and R26.

##### 2. Technical interfaces need to be agreed with every supplier

This issue, encountered by the 5G -LOGINNOV partners is from the same nature as the ones encountered and mentioned in the previous section, regulatory gaps. Technical interfaces are not standardised and agreements with every supplier need to be made for integration of equipment and services. In addition, the chance that this succeeds also depends on 'established relationship' with these suppliers.

The following recommendation was developed:

##### **R28 Standardize technical interfaces to reduce complexities for service and equipment providers and foster efficient operations.**

Establishment of a Technical Standards Committee consisting of experts from telecommunication service providers, equipment manufacturers, port authorities, and relevant stakeholders. The committee's primary responsibility will be to define and develop standardized technical interfaces for 5G deployment in ports and hinterland regions. In addition, the committee will also:

- Encourage the prioritization of Open Standards for 5G interfaces, allowing multiple suppliers to adopt them easily. Open standards will promote interoperability among

different equipment and service providers, reducing the dependency on specific suppliers and facilitating smooth integration.

- Conduct regular consultations with service and equipment providers, local authorities, and other relevant stakeholders to gather input and feedback on the development of technical interfaces. Involving stakeholders in the decision-making process will lead to more comprehensive and practical standards.
- Collaborate with regulatory bodies to ensure that standardization efforts align with national and international guidelines. Regulatory support will provide legal backing to the adoption of standardized interfaces and foster a consistent approach across different regions.
- Establish a testing and certification process to verify compliance with the standardized technical interfaces. Certification will help assure service and equipment providers that their solutions meet the required standards, promoting confidence and competitiveness in the market.
- Offer incentives and recognition to service and equipment providers that adopt and implement the standardized technical interfaces early. These incentives can include reduced licensing fees, access to special funding, or priority access to deployment sites.
- Organize technology showcases and share best practices that demonstrate the benefits of using standardized technical interfaces in 5G deployment. This will encourage service and equipment providers to embrace these interfaces, realizing the advantages they offer in terms of scalability and interoperability.
- Engage in international collaborations and knowledge-sharing initiatives to leverage global expertise in defining technical interfaces for 5G deployment. This will ensure that the standards align with international best practices and facilitate cross-border operations.
- Offer training programs and workshops to equip service and equipment providers with the necessary skills and knowledge to implement standardized technical interfaces effectively. Enhanced technical capabilities will enable them to streamline their operations and offer innovative solutions.

These policies simplify operations for service and equipment providers, fostering competition, and ensuring a smooth and efficient deployment of 5G technology, ultimately enhancing connectivity, productivity, and economic growth in these crucial areas.

## 4.1.5 Training and expertise

### 1. Address the lack of experience of early adapters in this new technology

5G is a relatively new technology and therefore misses deployment and operations 'best practices'. Currently, service providers are confronted with a lot of 'unknowns' that they need to solve themselves without an outlook of long-term successful implementation. To tackle this issue, the following recommendations can be made:

#### **R29 Build expertise for Seamless 5G Deployment in Ports and Hinterland: A Training and Knowledge-Sharing Initiative**

It is vital to promote specialized training, knowledge sharing, and expertise development to ensure successful and efficient 5G deployment and operation. It is also relevant to develop a comprehensive 5G training program tailored to the specific needs of ports and hinterland stakeholders. This program will offer specialized courses and workshops covering various aspects of 5G technology, deployment strategies, and best practices. Participants who successfully complete the program will receive a certification, enhancing their credibility and competence. Moreover, there will be regular evaluations of the training programs and knowledge-sharing initiatives to assess their effectiveness. Feedback from participants and stakeholders will be used to make necessary improvements and ensure the position's ongoing relevance.

Another action to take would be to forge partnerships with industry experts, technology providers, and academic institutions with expertise in 5G deployment. These collaborations will facilitate knowledge exchange, research, and the development of practical deployment and operations guidelines.

Additionally, it is recommended to organize regular knowledge-sharing forums, conferences, and workshops focused on 5G deployment in ports and hinterland regions. These events will

provide a platform for stakeholders to learn from each other's experiences, share best practices, and discuss challenges and solutions. Additionally, it is important to foster public-private partnerships to support the implementation of training programs and knowledge-sharing initiatives. Collaborating with private sector entities can bring in additional expertise, resources, and innovative solutions to accelerate the learning process.

### **R30 Create a centralized knowledge repository that consolidates 5G-related references**

The creation of a knowledge base that consolidates 5G-related references like research papers, case studies, and best practices specifically relevant to ports and hinterland areas is recommended. This repository will serve as a valuable resource for stakeholders seeking guidance in their 5G deployment journey.

Furthermore, it is relevant to encourage the establishment of 5G pilot projects and testbeds in select ports and hinterland regions. These initiatives will provide hands-on experience and opportunities for stakeholders to experiment with the technology in real-world scenarios, fostering practical expertise.

It is also important to provide grants and incentives to ports and hinterland stakeholders for investing in training and capacity-building initiatives related to 5G deployment. Financial support will motivate stakeholders to prioritize skill development and knowledge enhancement.

In the knowledge base, it would be relevant to create a dedicated technical support helpline or platform where stakeholders can seek expert advice and guidance on 5G deployment challenges and concerns. Prompt technical assistance will ensure that implementation hurdles are addressed effectively.

These recommendations will promote a skilled and knowledgeable workforce, enhancing the efficiency of 5G deployment and operations, and maximizing the potential benefits of 5G technology in these critical areas of transportation and logistics.

## **2. Lack of skilled people**

5G -LOGINNOV partners frequently were confronted with a lack of skilled people to advance in the deployment of the use cases foreseen in the project. This led to the following recommendation.

### **R31 Enhance Skilled Workforce and STEM Education for Successful 5G Deployment in Ports and Hinterland**

To address the shortage of skilled personnel, particularly in STEM (Science, Technology, Engineering, and Mathematics) fields, this recommendation aims to promote STEM education by developing specialized training packages, and allocating budgets for marketing initiatives to attract talent and ensuring a well-equipped workforce.

Additionally, it is advisable to collaborate with educational institutions to enhance STEM education at the primary, secondary, and tertiary levels. Also, to implement specialized curricula, workshops, and extracurricular activities to nurture interest and aptitude in technological fields among students. Design specialized training packages that cater to the specific needs of 5G deployment in ports and hinterland regions. These packages should cover technical skills, project management, regulatory compliance, and other relevant areas, ensuring a competent workforce.

Another action suggested under this recommendation is to create dedicated 5G Centres of Excellence in collaboration with universities, research institutions and industry. These centres will serve as hubs for cutting-edge research, technology development, and the training of skilled professionals in 5G deployment and operations. They will also provide, through partnerships between public institutions and private companies, 5G training opportunities for students, professionals, and existing workforce members. These partnerships will combine academic knowledge with real-world industry expertise.

Additionally, it is advisable to offer incentives and scholarships to attract STEM professionals to work in the field of 5G deployment in ports and hinterland areas. These incentives may include research grants, tuition fee waivers, or tax benefits for skilled personnel in the 5G domain.

And finally, it is important to implement lifelong learning initiatives to ensure that the workforce remains up to date with the latest advancements in 5G technology.

These recommended policies address the shortage of skilled personnel, improve project efficiency, and support the successful implementation of 5G technology in critical areas of transportation and logistics.

## 4.1.6 Business models

5G LOGINNOV partners were confronted with long lead times for the infrastructure to be ready that hampered the on-time delivery according to the planning. Installing private networks and making them operational was challenging as currently the MNO's business focus is on large scale deployment and consumer use and applications. To address these issues the following recommendation was made:

### **R32 Create a dedicated fund to support research and development of innovative business models.**

This fund will encourage start-ups, technology providers, and stakeholders to explore novel approaches to finance and monetize 5G networks. By fostering partnerships between public entities, private companies, and port authorities the setup of 5G infrastructure could be co-financed. These PPPs will enable faster deployment by sharing the financial burden and resources required for infrastructure development. Furthermore, it is advisable to encourage Mobile Network Operators to engage in partnerships with private networks deployed in ports and hinterland areas. Clear guidelines and revenue-sharing agreements will enable MNOs to extend their services to private networks effectively. In addition, facilitating the connection and integration of private networks in ports and hinterland regions with existing commercial networks will ensure smooth data exchange, enhanced coverage, and improved service quality.

It is also important to establish specialized incubators or innovation centres focused on creating business models that cater specifically to the needs of industries operating in ports and hinterland regions. These incubators will encourage collaboration between start-ups and industry players.

Moreover, and linked to previous recommendations to tackle the regulatory gaps, another action recommended is to work with regulatory authorities to create a flexible framework that supports the development and testing of various business models for 5G deployment. Regulatory sandboxing and pilot programs can allow stakeholders to experiment with new models before full-scale implementation.

Applying these recommendations will ensure seamless integration with commercial networks and stimulate the adoption of 5G for specific industrial use-cases, ultimately enhancing the efficiency and competitiveness of these critical areas of transportation and logistics.

## 4.2 Policy Framework 2: Enhance research, development and deployment of AI applications to support most optimal Logistic supply chain and port operation

The recommendations that are formulated in this section are a result of challenges faced during the deployment of the 5G-LOGINNOV innovations. They give an answer to the identified gaps on the categories presented in section 3.3.1.

### 4.2.1 Technical gaps

Under the technical gaps category, several issues were identified, and recommendations (R) developed.

#### **1. Are there AI and Software tools available to support the expected applications?**

The project partners faced some challenges when obtaining the AI and related software tools for the applications and services planned. The rapid advancement of Artificial Intelligence (AI) has created a growing demand for tools and software to support its applications and services, however, there is a noticeable lack of accessible, high-quality AI tools and software available to developers, businesses, and researchers. This gap hinders innovation and limits the widespread adoption of AI technologies. To address this issue, the following recommendations were developed.

#### **R1 Investment in Research and Development**

It is recommended to allocate government funding and incentives to support AI tool and software development projects. As previously mentioned, it is also relevant to encourage public-private partnerships to accelerate innovation in this sector. By establishing AI research centers and collaborations with academic institutions it will be easier to foster cutting-edge developments in AI tools and software.

### **R2 Stimulate Open-Source Initiatives**

The promotion and financial support of open-source AI projects can help democratize AI technology. It is important to encourage organizations and developers to contribute to open-source AI toolkits as well as support the creation of a centralized platform for hosting and showcasing open-source AI tools and software, making them easily accessible to the global AI community.

### **R3 Focus on standards and Interoperability**

It is vital to develop industry standards for AI tools and software to ensure compatibility and interoperability between different solutions. This will reduce fragmentation and enhance collaboration in the AI ecosystem. Additionally, it would be sensible to encourage AI companies and developers to adhere to these standards, possibly through incentives or certifications.

### **R4 Intellectual Property and Licensing Reform**

To strike a balance between protecting innovation and ensuring broader access to AI tools and software it is necessary to review and update intellectual property and licensing laws. Another action recommended would be to explore innovative licensing models, such as royalty-free licensing for non-commercial AI tools, to reduce barriers to entry.

### **R5 Ensure the availability of User-Friendly Interfaces and Documentation**

Encourage AI tool developers to prioritize user-friendly interfaces and comprehensive documentation to make their products more accessible to non-experts. Additionally, it is recommended to establish best practices and guidelines for creating intuitive AI tool interfaces and knowledge that has not yet arrived at the novel and technician levels.

## **2. Can AI Influence traffic management ideas/strategy?**

Efficient traffic management is crucial in modern urban environments to minimize congestion and enhance overall quality of life. Artificial intelligence plays a significant role in optimizing traffic flow and reducing still stand times in congested areas. However, gaps exist in effectively influencing traffic management strategies by leveraging real-time data and ensuring that successful approaches can be transferred to other cities.

### **R6 Ensure real time data**

One critical aspect of improving traffic management is to reduce still stand time, i.e., the period during which vehicles are stationary in traffic. To achieve this, control rooms need access to real-time data to make informed decisions. AI systems, equipped with sensors and cameras throughout the city, can provide control rooms with live feedback on traffic conditions. By analyzing these data, control rooms can implement strategies such as reducing speed limits or re-routing traffic to ease congestion.

### **R7 Work on standardized Protocols for Data Exchange**

Traffic management systems are often operated by local authorities, making data sharing and collaboration between cities a complex process. To address this issue, there is a demand for standardized protocols for data exchange, for instance, the Hamburg G5 initiative is pioneering the use of 5G technology to bridge data sharing gaps between cities. Standardization will enable seamless data exchange and foster collaboration between cities, allowing them to learn from each other's experiences and adopt successful strategies.

## **3. Collection of video frames for training/evaluation**

Overcoming the challenge of training artificial intelligence with a large dataset of video frames can be a complex endeavour. Below are some recommendations to address this problem.

### **R8 Data Management and Storage**

This recommendation can be divided in the following actions:

- **Scalable Storage Solution:** Invest in scalable and reliable data storage solutions, such as cloud-based storage or network-attached storage (NAS). This ensures that you have sufficient space for your video frame dataset.
- **Data Partitioning:** Divide the datasets into manageable partitions or subsets, making it easier to work with and process. It is also relevant to implement a clear organization system to keep track of the data.



- **Data Labelling Automation:** Explore automated or semi-automated labelling tools and techniques to reduce the manual labelling workload. These tools can help in annotating video frames efficiently.
- **Quality Control:** Implement quality control checks to ensure that the labelled data is accurate and consistent. This may involve human verification or additional validation steps.
- **Data Augmentation via Synthetic Data Generation:** Consider generating synthetic data to augment the dataset. Techniques like data synthesis through image transformation, style transfer, or Generative adversarial networks (GANs) can increase the diversity of your dataset.

#### R9 Parallel Processing of data

This recommendation is divided in the following actions:

- **Distributed Computing:** Utilize distributed computing or cloud-based resources to speed up data processing and model training. This enables training AI models faster by leveraging multiple processors or GPUs.
- **Reduced Frame Sampling:** Instead of using every frame, strategically sample frames to reduce the dataset size while preserving key information. Techniques like keyframe extraction or optical flow-based frame selection can be useful.

#### R10 Transfer Learning

There are a few actions grouped under this recommendation.

- **Pretrained Models:** Leveraging pretrained AI models and fine-tuning them with the datasets can significantly reduce the amount of data needed for training.
- **Data (video) Compression:** when possible, using video compression techniques to reduce the size of video files while maintaining essential details is recommended. However, there is a need to be cautious not to sacrifice too much quality.
- **Active Learning /Feedback Loop:** Implement an active learning strategy where the AI model selects which frames to label based on its uncertainty. This can optimize the labelling process.
- **Collaboration:** Encourage the collaboration with research institutions, universities, or organizations with similar data needs. Sharing datasets and resources can benefit all parties involved.

#### R11 Documentation and Version Control (ethics)

- **Proper Documentation:** It is important to maintain detailed documentation of the datasets, labelling procedures, and data processing steps. It is highly recommended to implement version control to keep track of changes and updates.
- **Ethical Considerations:** Closely linked to R27 from the previous section (4.1) it is important to ensure that the data collection process aligns with ethical guidelines, especially when dealing with video frames that may contain sensitive information. Implementing privacy and security measures as needed is recommended.

### 4. Huge amount of training data

Overcoming the challenges associated with a massive amount of training data, long model training times, intellectual property rights (IPR) issues, and ensuring transferability and co-creation models in the context of AI development is crucial.

#### R12 Recommendations to address the challenges to avoid huge amount of training

This recommendation is divided in 4 relevant actions:

- **Data Management and Sampling:** Instead of using the entire dataset, strategically sample a representative subset for training. Techniques like stratified sampling and active learning can reduce the data volume while maintaining model performance.
- **Data Preprocessing:** Apply data preprocessing techniques to reduce data dimensionality, remove noise, and enhance data quality.
- **Model Optimization:** Explore state-of-the-art models designed for efficiency, such as smaller neural architectures, quantization, or pruning techniques, which can reduce training time while preserving performance.

- **Distributed Training:** Utilize distributed training on multiple GPUs or TPUs to speed up the training process.

## 5. Increase Transferability in Artificial Intelligence (AI)

Increasing transferability in Artificial Intelligence (AI) is essential to promote the sharing and reusability of AI models, technologies, and knowledge. Transferability can accelerate innovation and the practical application of AI across various domains. Here are some recommendations to foster greater transferability in AI.

### R13 Share Model Architecture and Weights

When sharing a trained model, focus on sharing the model architecture and weights rather than the raw data. This can mitigate some transferability concerns.

### R14 Encourage Providing Documentation

Provide comprehensive documentation of the model architecture, data sources, and training procedures to aid in replicating and transferring the model.

### R15 Develop a process for fine-tuning models

It is recommended to develop processes for fine-tuning models on new data in the target environment, and transfer learning techniques can be valuable for adaptation.

### R16 Foster collaboration to co-create AI models

Forster the organization of collaborative workshops or hackathons where stakeholders, including domain experts, can work together to co-create AI models. This fosters a sense of shared ownership and domain expertise.

### R17 Strive for Generic Models

When applicable, it is encouraged to design AI models to be more generic and adaptable to different domains. Furthermore, instead of domain-specific models it would be recommended to create architectures that can be fine-tuned for various applications.

## 6. Address Domain-Specific Challenges (e.g., security and safety)

Addressing domain specific challenges such us security and safety could be challenging.

### R18 Stimulate Domain Expertise

Involve domain experts early in the AI development process to better understand specific needs, challenges, and safety concerns.

### R19 Ensure Regulatory Compliance

Ensure compliance with industry regulations and safety standards when developing AI models for sensitive domains like security and safety.

## 4.2.2 Infrastructure and Installation gaps

Within this category some issues were identified, and several recommendations developed.

### 1. Availability of cloud environments and AI tools.

There were a lot of problems when integrating these tools in existing ICT environments such us security, privacy, etc. Dedicated cloud environments like port and mobile Infrastructure as a Service (IaaS) require compliance with internal port procedures. Specifically for cranes in ports, any modification to the infrastructure is prohibited by the manufacturer. This leads to the following recommendation:

### R20 Enhance Standardization

Promote the use of standardized protocols and interfaces to ensure smooth integration, allowing different AI applications to work together and with existing ICT infrastructure.

## 2. Problems in handling to equip port assets

To support logistics processes at port environments solutions are needed for camera placements on the infrastructure, like on top of the cranes, that make sense for the AI services, but also that they do not affect the crane design, and intent, as specified by the manufacturer.

There is also the issue of ownership of this type of port equipment that could prevent immediate installation. Installation also affects the right to repair and maintain the installation. This leads to the following recommendation.

### **R21 Enhance the collaboration with Equipment Manufacturers and ensure design neutrality**

Actively engage with equipment manufacturers to develop camera placement solutions that align with the AI service requirements without compromising the original design and intended functionality of the infrastructure and vehicles (e.g., cranes and trucks). Designs should be neutral, adaptable, and non-intrusive to the equipment's structural design and intended purpose.

Another issue that arose during the deployment was related to the investment and maintenance of the hardware and infrastructure. To tackle this issue, the following recommendation was developed.

### **R22 Hardware and Infrastructure investment and maintenance**

- **High-Performance Computing:** It is encouraged to invest in high-performance computing (HPC) resources, including powerful GPUs and CPUs, to accelerate the training process.
- **Regular Maintenance:** Regularly clean and curate the datasets to remove redundant or irrelevant data, ensuring that the datasets remain manageable and relevant to the relevant AI objectives.

## 4.2.3 Regulatory gaps

Several issues were identified under this category and the following recommendations were developed.

### **1. The installation and operation are not within the current law**

Regulatory gaps, including the absence of clear approvals, legislative voids, and the inability of current laws to keep up with evolving technologies, require the establishment of a comprehensive policy to address these issues. The following recommendation is suggested.

### **R23 Encourage collaboration with legislative bodies**

Collaboration with relevant legislative bodies is encouraged to bridge gaps and ensure that AI installations and operations fall within the purview of the law. It is also encouraged to collaborate with stakeholders to develop clear and efficient approval processes for AI technologies, addressing issues of installation and operation that may fall outside current legal frameworks. In addition, it is crucial to develop transparent and consistent rules and guidelines for AI technology deployment, creating a regulatory framework that benefits all stakeholders.

## 4.2.4 Administrative issues

Some administrative hurdles were identified by the project partners and recommendations to overcome them were developed.

### **1. Addressing the hurdle of fulfilling huge amount of forms**

These forms had to be prepared and disseminated across the port personnel, as the training data required consent by the employees. Training data included the video frames for human presence detection service, which in certain cases included the presence of employees in the field of view of the cameras. And therefore, that required a need for certificates, registrations, compliance tests, etc.

### **R24 Need for guidance and an inventory on needed administrative documents**

There is a need for guidance and an open inventory of administrative documents needed, as well as clear instructions on which authority to address.

## 2. Timely planning for testing

There is a need to plan development, testing, integration, and validation activities in such a way not to pose any obstacle to the regular port operations.

### **R25 Administrative issues included in planning phase**

It is crucial to include any administrative procedures in the planning phase and allocate ample time to accommodate them.

## 4.2.5 Training and expertise

Gaps were identified under the training and expertise category; the developed recommendations can be found below.

### **1. Address the lack of experience of early adapters of the technology**

Experts are needed to understand the complexity and difficulty of how these technologies work and how to operate the equipment, however, there is a scarcity of people with the required technical skills. During the project, training of the IT team had to be done for employees of the port to be able to use the service without assistance.

#### **R26 Foster Tailored Training and Access to Training Resources**

It is recommended to develop specialized training programs to address the specific needs of early adopters and technical staff, covering the fundamentals of AI technology, installation procedures, and operational knowledge. In addition, it is important to ensure easy access to training resources, including online courses, expert-led sessions, and comprehensive documentation to support learning and skill development.

#### **R27 Foster Education and Skill Development**

Invest in educational programs and initiatives to train a diverse workforce in AI tool and software development. These programs should be accessible and affordable to encourage participation from underrepresented groups. Furthermore, lifelong learning opportunities for AI professionals to keep their skills up-to-date with the evolving landscape should be promoted.

## 4.2.6 Business models

An exhaustive list of business-related recommendations can be found in *D4.3 Achievements with new actors and opportunities*, in this section a few challenges and recommendations are highlighted that are key to Enhance research, development and deployment of AI applications.

### **1. Resistance from the customer or entrepreneurs to invest**

There seems to be a resistance from customers or entrepreneurs to investing as there is not a clear difference in objectives between societal benefits and private company objectives. There is also a need for robust business development. To address these challenges while focusing on innovation, the mindset and the emphasis should be on Return on Investment (ROI) rather than just cost. The following recommendation can be made.

#### **R28 Cultivate an innovation-driven mindset**

Incentivize initiatives that encourage experimentation and learning from both successes and failures. In addition, it is important to promote a collaborative culture that fosters cross-functional collaboration, knowledge sharing, and co-creation of business strategies.

### **2. Deal with Intellectual Property Rights (IPR)**

Recommendations for dealing with Intellectual Property Rights (IPR) in Artificial Intelligence (AI) should aim to strike a balance between fostering innovation, protecting creators, and ensuring that AI technologies are used for the benefit of society. Here are some key policy recommendations in this regard:

### **R29 Establish Collaborative Agreements**

When dealing with IPR issues, it is relevant to consider establishing collaborative agreements or partnerships with data owners to negotiate data sharing terms. Clear contractual arrangements can facilitate data access and model sharing.

### **R30 Focus to Data Licensing**

Exploring data licensing options, where data can be purchased or be licensed while adhering to IPR restrictions is crucial. It is also relevant to ensure legal experts review and negotiate licensing agreements.

### **R31 Ensure Data Anonymization**

Anonymize sensitive data to protect IPR while still using valuable information for model training.

## **3. Difficulty to calculate the full costs**

Excessive costs are involved in the deployment of these technologies, it is usually hard to find the right components. This leads to the following recommendation:

### **R32 Provide transparency in costs**

It is important to maintain transparency in cost estimations, clearly documenting all cost components and the reasoning behind budget allocations to provide stakeholders with a better understanding of project expenses.

Applying these recommendations will ensure the development and deployment of AI applications to support the optimal logistic supply chain and port operations, ultimately enhancing the efficiency and competitiveness of these critical areas of transportation and logistics.



## 5 DEPLOYMENT OPTIONS & STAKEHOLDERS' IDENTIFICATION

This section will focus on the deployment options for the recommendations, namely, to identify and address the relevant stakeholders and policies.

### 5.1 Addressing the recommendations towards the Logistic stakeholders

The next tables present a list of the stakeholders the recommendations developed address.

The following stakeholders were identified with the support of Deliverable 8.2 (business and user engagement strategy) from the AEOLIX<sup>7</sup> project and the 5G-LOGINNOV partners:

- Public authorities (Local; Regional and National)
- Policy makers (Member states and EU level)
- Industry (Shippers, transport companies (carriers) and forwarders; Terminal and hub operators and Technology providers)
- Telecommunication operators (Operators and Suppliers)
- Research and universities
- Standardization organizations

The following tables give hints on how the recommendations should address the interests of the logistic industry stakeholders to act.

#### 5.1.1 Policy Framework 1: Ensure priority roll out of 5G networks on EU hinterland network and port area

These 32 recommendations (lessons learned) developed under the 5G-LOGINNOV project are aimed/addressed to different logistic industry stakeholders. In the table below a list of the recommendations and the stakeholders to whom they are addressed to can be found.

\* *Shippers, transport companies (carriers) and forwarders*

Recommendations*	Stakeholders											
	Public authorities			Policy makers		Industry			Telecom		Public authorities	Standardisation
	Local	Regional	National	Member States	EU level	Tech. providers	Port operators	Shippers*	Suppliers	Operators		
R1 Implement the OCIT Standard Data Protocol for Equipment Across EU Ports			x	x	x		x		x	x		x

<sup>7</sup> AEOLIX: <https://aeolix.eu>

R2 Encourage Cities to Collaborate on a Common Data Interface for Legacy Standards		x		x	x							
R3 Ensure Longevity of Traffic Information Equipment and Support Certified Suppliers						x	x	x	x	x		
R4 Legacy infrastructure	x						x	x	x			
R5 Strengthening the IoT Market for Industrial-Grade Equipment and Solutions			x	x	x						x	
R6 Establish industry-wide guidelines and standards for industrial-grade 5G equipment and components		x	x		x							x
R7 Enhancing collaboration with industry stakeholders, research institutions, and technology providers		x	x	x	x		x		x			
R8 Provide financial incentives and support for start-ups and small to medium-sized enterprises (SMEs) in the IoT domain		x	x		x							
R9 Address responsibility of Mobile Network providers to prioritize Supply Chain Enhancement for 5G-related Equipment and Services					x	x	x	x	x	x		
R10 Proactive role in Regulation and Network Coverage		x	x	x	x							
R11 Focus on Transport and Mobility, including Cross-border Connectivity			x		x							
R12 Balancing Focus on Different Sectors			x		x				x		x	x
R13 Facilitating Private 5G Networks and Spectrum Assignment									x	x	x	x
R14 Encourage the implementation of network slicing in 5G networks for Versatility and Efficiency			x		x		x		x	x	x	x

R15 Encourage collaboration between Private Networks and Public Infrastructure	x	x	x		x	x		x					
R16 Addressing the critical issue of missing policies and regulations on cybersecurity in the context of rapidly evolving technologies	x	x	x	x	x								
R17 Ensure agility in Legislative Updates	x	x	x	x	x								
R18 Capacity Building and Awareness Initiatives	x	x	x	x	x								
R19 Ensure reliable and consistent low-latency performance in 5G networks								x	x	x	x	x	x
R20 Monitoring and Enforcement of SLAs								x	x	x	x	x	x
R21 Ensure compatibility of port infrastructure	x	x	x	x	x	x	x	x	x	x	x	x	x
R22 Recognise the significant advantages of 5G.	x	x	x	x	x	x	x	x	x	x	x	x	x
R23 Facilitate the deployment of 5G networks by leveraging economies of scale and implementing initial subsidies in strategic sectors	x	x	x					x	x		x	x	
R24 Foster collaboration among public and private partners to establish partnerships, enhance the cost-effectiveness deployment	x	x	x					x	x		x	x	
R25 Address the existence of regulatory gaps in the deployment and management of 5G networks	x	x	x									x	x
R26 Facilitate the exchange of best practices and knowledge-sharing between member states	x	x	x									x	x
R27 Implementing a streamlined and standardized approach that balances data privacy concerns with	x	x	x										x



deployment of 5G services													
R28 Standardize technical interfaces to reduce complexities for service and equipment providers and foster efficient operations	x	x	x				x				x		x
R29 Build expertise for Seamless 5G Deployment in Ports and Hinterland: A Training and Knowledge-Sharing Initiative	x	x	x	x	x							x	
R30 Create a centralized knowledge repository that consolidates 5G-related references	x	x	x									x	
R31 Enhance Skilled Workforce and STEM Education for Successful 5G Deployment in Ports and Hinterland	x	x	x	x	x							x	
R32 Create a dedicated fund to support research and development of innovative business models	x	x	x	x	x						x	x	

**Table 4:** List of recommendations and stakeholders to address (policy framework 1)

### 5.1.2 Policy Framework 2: Enhance research, development and deployment of AI applications to support most optimal Logistic supply chain and port operation

These 32 recommendations (lessons learned) developed under the 5G-LOGINNOV project are aimed/addressed to different logistic industry stakeholders. In the table below a list of the recommendations and the stakeholders to whom they are addressed to can be found.

\* Shippers, transport companies (carriers) and forwarders

Recommendations*	Stakeholders												Standardisation
	Public authorities			Policy makers		Industry			Telecom		Research & Universities		
	Local	Regional	National	Member States	EU level	Tech. providers	Port operators	Shippers*	Suppliers	Operators			
R1 Investment in Research and Development	x	x	x	x	x	x	x	x	x	x	x	x	

R2 Stimulate Open-Source Initiatives				X	X	X	X	X	X	X	X	
R3 Focus on standards and Interoperability				X	X	X	X	X	X	X	X	X
R4 Intellectual Property and Licensing Reform				X	X	X	X	X	X	X	X	
R5 Availability of User-Friendly Interfaces and Documentation						X	X	X	X	X	X	
R6 Ensure real time data	X	X	X	X								
R7 Work on standardized Protocols for Data Exchange	X	X	X	X	X							X
R8 Data Management and Storage						X	X	X	X	X	X	
R9 Parallel Processing of data						X	X	X	X	X	X	
R10 Transfer Learning						X	X	X	X	X	X	
R11 Documentation and Version Control (ethics)					X	X	X	X	X	X	X	
R12 Address the challenges to avoid huge amount of training						X	X	X	X	X	X	
R13 Share Model Architecture and Weights						X	X	X	X	X	X	
R14 Encourage Providing Documentation						X	X	X	X	X	X	
R15 Develop a process for fine-tuning models						X	X	X	X	X	X	
R16 Foster collaboration to co-create AI models	X	X	X	X	X	X	X	X	X	X	X	
R17 Strive for Generic Models						X	X	X	X	X	X	
R18 Stimulate Domain Expertise						X	X	X	X	X	X	
R19 Ensure Regulatory Compliance	X	X	X	X	X	X	X	X	X	X	X	
R20 Enhance Standardization					X	X	X	X	X	X	X	X
R21 Collaboration with Equipment Manufacturers & design neutrality						X	X	X	X	X	X	
R22 Hardware and Infrastructure investment and maintenance						X	X	X	X	X	X	
R23 Encourage collaboration with legislative bodies	X	X	X	X	X	X	X	X	X	X	X	
R24 Guidance and inventory on needed administrative documents	X	X	X	X	X							
R25 Administrative issues included in planning phase						X	X	X	X	X		
R26 Foster Tailored Training and Access to Training Resources	X	X	X	X	X	X	X	X	X	X	X	
R27 Foster Education and Skill Development	X	X	X	X	X	X	X	X	X	X	X	

R28 Cultivate an innovation-driven mindset	X	X	X	X	X	X	X	X	X	X	X	
R29 Establish Collaborative Agreements						X	X	X	X	X		
R30 Focus to Data Licensing						X	X	X	X	X		
R31 Ensure Data Anonymization					X	X	X	X	X	X		
R32 Provide transparency in costs						X	X	X	X	X		

**Table 5:** List of recommendations and stakeholders to address (policy framework 2)

## 5.2 Cross referencing the recommendations with the related EU policies

Section 2 of this deliverable outlined the existing high level EU policies. On this section, an analysis was performed to determine if the recommendations developed could fit and complement the already established policies. The table presented below is a cross reference that can help give insight on how a recommendation can support or be part of the accepted EU policies and be a stimulation for deployment.

### 5.2.1 Policy Framework 1: Cross referencing the recommendations with the 5G related EU policies

The following table can give some insight on how the recommendations fit and support the 5G EU policies:

Recommendations	5G relevant EU policies							Most impacting recommendations (totals of rows)
	5G action plan	Spectrum Allocation & harmonisation	Cybersecurity in 5G Networks	EU Electronic Communications Code	5G Public-Private Partnership (PPP)	Digital Single Market Strategy	Horizon 2020	
R1 Implement the OCIT Standard Data Protocol for Equipment Across EU Ports	1				1	1		3
R2 Encourage Cities to Collaborate on a Common Data Interface for Legacy Standards	1				1	1		3
R3 Ensure Longevity of Traffic Information Equipment and Support Certified Suppliers				1		1		2
R4 Legacy infrastructure	1				1			2
R5 Strengthening the IoT Market for Industrial-Grade Equipment and Solutions					1	1	1	3

R6 Establish industry-wide guidelines and standards for industrial-grade 5G equipment and components	1				1	1		3
R7 Enhancing collaboration with industry stakeholders, research institutions, and technology providers	1				1			2
R8 Provide financial incentives and support for start-ups and small to medium-sized enterprises (SMEs) in the IoT domain							1	1
R9 Address responsibility of Mobile Network providers to prioritize Supply Chain Enhancement for 5G-related Equipment and Services				1	1	1		3
R10 Proactive role in Regulation and Network Coverage	1			1	1	1		4
R11 Focus on Transport and Mobility, including Cross-border Connectivity	1			1		1		3
R12 Balancing Focus on Different Sectors	1				1			2
R13 Facilitating Private 5G Networks and Spectrum Assignment		1				1	1	3
R14 Encourage the implementation of network slicing in 5G networks for Versatility and Efficiency		1	1			1	1	4
R15 Encourage collaboration between Private Networks and Public Infrastructure	1				1	1	1	4
R16 Addressing the critical issue of missing policies and regulations on cybersecurity in the context of rapidly evolving technologies	1			1	1	1		4
R17 Ensure agility in Legislative Updates	1			1	1	1		4
R18 Capacity Building and Awareness Initiatives	1				1	1		3
R19 Ensure reliable and consistent low-latency performance in 5G networks		1			1	1	1	4
R20 Monitoring and Enforcement of SLAs				1		1		2
R21 Ensure compatibility of port infrastructure					1	1	1	3
R22 Recognise the significant advantages of 5G.					1	1	1	3
R23 Facilitate the deployment of 5G networks by leveraging economies of scale and implementing initial subsidies in strategic sectors	1				1	1		3
R24 Foster collaboration among public and private partners to establish partnerships, enhance the cost-effectiveness deployment	1				1	1		3
R25 Address the existence of regulatory gaps in the deployment and management of 5G networks	1			1		1		3
R26 Facilitate the exchange of best practices and knowledge-sharing between member states	1					1	1	3
R27 Implementing a streamlined and standardized approach that balances data privacy concerns with deployment of 5G services			1			1		2

R28 Standardize technical interfaces to reduce complexities for service and equipment providers and foster efficient operations					1	1	1	3
R29 Build expertise for Seamless 5G Deployment in Ports and Hinterland: A Training and Knowledge-Sharing Initiative					1		1	2
R30 Create a centralized knowledge repository that consolidates 5G-related references	1					1		2
R31 Enhance Skilled Workforce and STEM Education for Successful 5G Deployment in Ports and Hinterland					1		1	2
R32 Create a dedicated fund to support research and development of innovative business models						1	1	2
<b>Most relevant EU policy (total columns)</b>	<b>17</b>	<b>3</b>	<b>2</b>	<b>8</b>	<b>21</b>	<b>25</b>	<b>12</b>	

**Table 6: How the recommendations fit and support 5G focused EU policies**

From this table, it can be concluded that the most impactful recommendations related to 5G policies are:

- R10 Proactive role in Regulation and Network Coverage
- R14 Encourage the implementation of network slicing in 5G networks for Versatility and Efficiency
- R15 Encourage collaboration between Private Networks and Public Infrastructure
- R16 Addressing the critical issue of missing policies and regulations on cybersecurity in the context of rapidly evolving technologies
- R17 Ensure agility in Legislative Updates
- R19 Ensure reliable and consistent low-latency performance in 5G networks

Most relevant EU policy that could be complemented:

- Digital Single Market Strategy

Another relevant policy, in this case partnership:

- 5G Public-Private Partnership (PPP)

### 5.2.2 Policy framework 2: Cross referencing the recommendations with EU policies on optimal Logistic supply chain and port operation.

On this section, an analysis was performed to determine if the recommendations developed could fit and complement the already established policies. The following table present some insights on how the recommendations fit and support the AI EU policies:

Recommendations	Identified AI related EU policies								Most impacting recommendations (totals of rows)	
	Ethics & Trustworthy AI	AI strategy	Expert group	AI act	Data strategy	Digital Services act & Digital Markets act	Investment in research	International co-operation		AI in specific sectors
R1 Investment in Research and Development		1	1		1		1			4

R2 Stimulate Open-Source Initiatives		1	1		1		1			4
R3 Focus on standards and Interoperability		1	1						1	3
R4 Intellectual Property and Licensing Reform		1	1	1						3
R5 Availability of User-Friendly Interfaces and Documentation			1				1		1	3
R6 Ensure real time data		1	1							2
R7 Work on standardized Protocols for Data Exchange		1			1	1	1			4
R8 Data Management and Storage		1			1	1	1			4
R9 Parallel Processing of data		1			1	1	1			4
R10 Transfer Learning		1	1							2
R11 Documentation and Version Control (ethics)	1	1			1	1	1			5
R12 Address the challenges to avoid huge amount of training	1	1		1	1		1			5
R13 Share Model Architecture and Weights		1	1	1	1		1			5
R14 Encourage Providing Documentation			1				1		1	3
R15 Develop a process for fine-tuning models							1			1
R16 Foster collaboration to co-create AI models			1		1			1		3
R17 Strive for Generic Models			1		1		1			3
R18 Stimulate Domain Expertise			1						1	2
R19 Ensure Regulatory Compliance	1	1		1	1					4
R20 Enhance Standardization		1			1	1	1			4
R21 Collaboration with Equipment Manufacturers & design neutrality						1		1	1	3
R22 Hardware and Infrastructure investment and maintenance						1		1	1	3
R23 Encourage collaboration with legislative bodies	1	1		1				1		4
R24 Guidance and inventory on needed administrative documents	1			1		1				3
R25 Administrative issues included in planning phase	1			1		1				3
R26 Foster Tailored Training and Access to Training Resources			1			1	1			3
R27 Foster Education and Skill Development			1	1	1	1		1	1	6
R28 Cultivate an innovation-driven mindset		1	1		1		1			4

R29 Establish Collaborative Agreements		1				1		1		3
R30 Focus to Data Licensing	1	1						1		3
R31 Ensure Data Anonymization	1	1		1	1		1			5
R32 Provide transparency in costs	1					1		1		3
Most relevant EU policy (total columns)	9	19	15	9	15	13	16	8	7	

**Table 7: How the recommendations fit and support AI focused EU policies**

From this table, it can be concluded that the most impacting recommendations related to AI policies:

- R27 Foster Education and Skill Development

Other recommendations with high impact are:

- R11 Documentation and Version Control (ethics)
- R12 Address the challenges to avoid huge amount of training
- R13 Share Model Architecture and Weights
- R31 Ensure Data Anonymization

Most relevant EU policies:

- AI strategy
- Investment in research



## CONCLUSIONS

This document described the applied methodologies and the actions taken to make an inventory of the 'Lessons learned' and the formulation of the 'recommendations for stakeholders' derived from the 5G-LOGINNOV project.

This deliverable delves into two core policy frameworks: the priority deployment of 5G networks in the EU's hinterland and port areas, and the augmentation of AI applications for optimizing logistical supply chains and port operations. Identifying the pivotal innovations and outputs from this project that can power further 5G deployment is crucial. Technical workshops highlighted these outputs, aligning them with the pertinent roadmaps that shape 5G's future.

By assessing the challenges faced by the living labs in implementing these innovations, a clear picture emerges of the critical issues demanding attention to improve project objectives and ensure transferability. Through categorization of identified gaps and extensive workshops and interviews with external stakeholders, the project developed an exhaustive 64 recommendations. These recommendations are thoughtfully designed to address technical issues, infrastructure barriers, regulatory challenges, administrative difficulties, expertise gaps, and business model obstacles that surround the successful implementation of 5G in EU ports.

Under the first policy framework, the suggestions encompass solutions for compatibility, infrastructure, regulatory, administrative, training, and business model challenges. Simultaneously, the second policy framework recommendations focus on investing in AI tools, data protocols, hardware enhancements, and policy collaborations, aligning them with the logistical and port operation objectives.

Furthermore, this deliverable lays out a detailed set of recommendations paired with the stakeholders they target public authorities, policy makers, industry players, telecommunication operators, research and academic institutions, and standardization organizations. The final sections underscore proposed strategies that encompass deploying innovations, enhancing transferability, and addressing stakeholders' recommendations within the logistics industry, aligning the strategies with pertinent EU policies.

Ultimately, this deliverable is a comprehensive guide, meticulously devised to fuel 5G technology across Europe's logistics landscape, aligning with the most current and future EU policies.

By making an inventory of these recommendations a first step is set in the process for improvement and further successful deployment of the innovations across European ports and hinterlands. An attempt was made to detect the most relevant deployment strategies by crosslinking the existing relevant position landscape with the established recommendations from the project. This action led to the formulation of 2 policy frameworks under which several recommendations were developed to ensure future successful deployment of 5G technologies.





# ANNEXES

## Annex 1: Internal Workshop's outputs

Roadmaps			Major 5G Loginnov Deliverables															Totals			
			Green light speed advice (impact mainly for platoon)	Impact traffic management - Increase speed - less CO2	Collision avoidance system (between truck and people)	Protecting Vulnerable road users	seal protection (Validates the content of the container)	Predictive maintenance	facilitating hand over of container between external and port internal	Coordinat ion external and internal truck	Tailored public 5G network in port	Private stand alone 5G network	Industrial grade 5G Gateway to connect sensors, cameras, ...	5G enabled AI for supporting logistic processes	Remote telemetry monitoring	Precise positioning	Wearable camera and drones		Fixed cameras (AI supported)	Security surveillance Video streaming ...	Others: Your input
ERTICO Logistics <small>(https://ertico.com/focus-area/transport-logistics/)</small>	2022	Hubs and traffic management for seamless mobility management systems	2	2				1	1	1		2	2	3	2	1	1	1		19	
	2025	Full digitalisation and automation of T&L (Transport & Logistics), interoperability on trusted data exchange in T&L	1		2		3	2	1		4	4	4	3	3	2	2	3	3	37	
	2030	Seamless and interoperable T&L towards physical internet					1		1		2	2	2	2	1	2	1	1	1	16	
Alice <small>(https://www.etp-logistics.eu/wp-content/uploads/2019/12/Alice-Zero-Emissions-Logistics-2050-Roadmap-WEA.pdf)</small>	2050	Freight demand growth is managed	1		1		1		1	1	1	1	2	1	1					13	
		Transport modes are smartly used and combined	2		2	1		1	1	1	1	1	2	1	1	1				16	
		Fleets and assets are shared and used to the max.				2			2		1		1	2	1	1	1			12	
		Fleets and assets are energy efficient	3	1				1		1			2	1	1					10	
		Fleets and assets used lowest emission energy source feasible	2				1		1			1		1					6		
SGPP roadmap <small>(https://sgpp.eu/wp-content/uploads/2018/11/SGPP-Trail-kiWG-Roadmap_Version4.0.pdf)</small>	2030	5G deployment and commercialisation	1		2	1	1	1	1	1	3	1	3	3	1	2	3	2		27	
		Private networks			2	1	1	1	1	1	3	2	2	2	1	2	2	1		23	
SGIA <small>(Infrastructure association, https://www.corenect.eu/roadmap)</small>	2030	Separate domains develop and offer a large variety of use cases	1									1	1	1	1					1	
<b>Highway and corridors</b>																				5	
<i>infra and bus models</i>																				0	
<i>technology enablers</i>																				0	
<i>Validation (homologation and standards)</i>																				0	
<i>AI and data analytics</i>																				0	
<b>Confined areas</b>		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	
<i>infra and bus models</i>		1		1	1															3	
<i>technology enablers</i>																				0	
<i>Validation (homologation and standards)</i>																				0	
<i>AI and data analytics</i>		1		1	1															3	
<b>Urban mixed traffic</b>		1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	14	
<i>infra and bus models</i>		1		1	1															3	
<i>technology enablers</i>																				0	
<i>Validation (homologation and standards)</i>																				0	
<i>AI and data analytics</i>	1		1	1															3		
<b>Rural roads</b>				1	1								1	1	1				3		
<i>infra and bus models</i>																			2		
<i>technology enablers</i>																			0		
<i>Validation (homologation and standards)</i>																			0		
<i>AI and data analytics</i>				1	1														2		
																			0		
ERTICO CCAM <small>(https://ertico.com/focus-area/connected-automated-driving/)</small>	2023	Increased awareness about CCAM societal impacts and methodologies for co-creation				1														1	
	2025	CCAM progresses through Mobility Data Space, edge computing, big data and AI (artificial intelligence)	1		1	1		1			1	1	1	1	1					10	
	2027	Infrastructure and connectivity needs for HLA (High Level Architecture) & common definitions for infrastructure adaptation & digital twins	1		1			1			1	1	1	1	1					9	
	2030	Better understanding of wider impacts of AD (Automated Driving) for passenger and logistics	1		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	
	2035	Integrated, Accepted, Inclusive and infrastructure support operational CCAM services, supporting the decarbonisation	2	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	20	
<b>Totals</b>			<b>24</b>	<b>5</b>	<b>22</b>	<b>19</b>	<b>10</b>	<b>17</b>	<b>10</b>	<b>12</b>	<b>19</b>	<b>19</b>	<b>21</b>	<b>27</b>	<b>24</b>	<b>21</b>	<b>15</b>	<b>14</b>	<b>12</b>	<b>0</b>	<b>200</b>

Table 8: List of roadmaps and outputs from the 5G-LOGINNOV project identified by the partners

## Annex 2: Internal Workshop's outputs II

		Hamburg	Koper	Athens-v2
What specific issues arose when deploying the project solutions in hinterland network and port area	Technical	Legacy infrastructure like traffic lights and the related/used roadside units are not suited for immediate technical implementations, Data availability not guaranteed by owner.	5G chipset availability, new software & HW components stability, COTS Industrial grade equipment difficult to obtain - Dedicated frequency bands for deployments in port are lacking -5G Cybersecurity policy and regulation within Port -	Given COVID pandemic, we experienced a lot of issues in acquiring the HW components for the use cases including IoT nodes, 4K cameras, 5G interfaces etc. This impacted the type of e.g., IoT nodes available, but also the quantity available, which also had a direct impact on the cost of each component. In summary delays in delivery, increased costs, limitations in type and quantity of HW components
	Administrative	traffic infra is under local authority, access is defined by agreements and technical interfaces agreed on.		Vodafone is the MNO of the Athens LL which cooperates with Piraeus Port for cellular communications before 5G-LOGINNOV project. Hence a lot of regulatory and administrative issues where straightforward, given their long established collaboration
	Regulatory	Use of traffic light data via the defined interfaces base on agreements with local authorities. But privacy laws prevent to use cameras.	Clear 5G Cybersecurity regulations for these environments is missing	
	Training-expertise	Used solutions are self explained as Apps are. Concerning the infrastructure of roadside units have been ordered from the local authorities including setup and maintenance.	Learning curve --totally new technology how to use it, missing deployment and operations best practices - missing production-ready 5G SA reference in Europe	
	Infrastructure /Installation	Legacy infra (802.11.p) is complete different network --5G is complete new technology--All new equipment must have cellular inside. (1800 traffic lights in Hamburg... A long time is needed	Commercial equipment is available but because of missing regulatory policy (e.g. EU 5G Toolbox for ports) for critical infrastructures cybersecurity constraints are not clear (connectivity with internal existing network--need to rebuild networks for the private network (example railway has dedicated harmonized frequency band for the EU	5G basestation hw components were installed on a Pillar at Pier II of Piraeus Port. Pillar had to be re-inforced to support the weight of the equipment
	Cost	Up to local authorities	Lacking chipsets--> High cost (10* cost of 4G)	increase cost of hardware components (5G Ifaces, cameras, IoT nodes, etc.) due to hardware shortage
	Business model not clear	Long lead times for infra	2 type of infra-- using shared commercial network infrastructure--using dedicated private network infrastructure-- commercial infrastructure also needs to be extended to be interconnected to the private -Deployment and operational model needs for private network needs to be defined (deployed by port, Fully skilled people needed, external subcontractor,?) or engage MNO ( but their bus model i. not clear for such network)	
	Is the port business for 5G prior to consumer business (business model (cost-revenue) for the operator)	A lot of support was received-Public network used in Hamburg -mostly sufficient enough but not always (CO2 ok) but low latency for roaduser safety was not always secured		Up speeding logistic-personel safety, (remove perso from unsafe place)
Societal value that port operations bring is higher than the societal value brought by consumer 5G applications	Is this true?	Hinterland connection shows emissions in the city (5%)Stand still time .....	Authorities and government are interested-ports are very important critical infrastructure for the EU - more than 70% of EU goods are import-export via ports-Smart ports (5G) - digitalization and automation is a must for reaching future sustainable goals.	same with Koper
	What can we do about it?	done --process		
	How to stimulate ?			
Capacity building				

**Table 9: Answers from Living labs regarding policy framework 1**

		Hamburg	Koper	Athens	Athens -v2
What specific issues arose when deploying these functionalities	Technical	influence traffic mgt ideas/strategy-one aspect =reducing still stand time--conrol room gets feedback from real time-- what was the result of the action (e.g. reduce speed -influence of different strategies--can be transferred to other cities	see Athens	video frames have to be collected for training/evaluation-Software tools -transfer to Koper to understand the delta needs	In Athens LL several AI services, enabled via 5G and video analytics are developed. We developed two types of applications: i) mission critical services tailored to the employees safety and ii) applications focused on expediting logistics operations. For all services, a huge amount of training data (i.e., video frames) had to be collected, in order to have high accuracy ML services tailored to the port environment. This is a cumbersome and time-consuming process. For instance, for the container seal detection service, we acquired more than 50K original video frames depicting container seals.
	Administrative				As we develop, demonstrate and integrate our services and software stack in a real Port environment (TRL 5-7), we also had to very carefully plan our development, testing, integration and validation activities in such a way that we make sure that we do not pose any obstacle to the regular port operations.
	Regulatory			Video feeds of personel (Privacy 0-They have to comply-Regulation--inform the employees	Several consent forms had to be prepared and disseminated across the Port personel, as the training data required consent by the employees. Training data include the video frames for human presnce detection service, which in cases includes the presence of employes at the field of view of the cameras. This requires consents
	Training-expertise			Video feeds of personel (Privacy 0-They have to comply-Regulation--inform the employees	All services developed by the project follow a cloud native software stack paradigm developed by ICCS. Hence, c
	Infrastructure /Installation		dedicated cloud environment Port & Mobile IaaS was prepared assured with GPUs to support AI/ML process (e.g. Video streams analysis) and to collect other IoT related sensor and telemetry information from port equipment (e.g. port tactor equipment connected to their CAN bus)-- needs to be in compliance with internal port procedures, regulatory and WITH equipment suppliers constraints (Standardisation needed?)	Small object detection -high resolution needed for reliable result --Cranes for loading and unloading modification is not allowed by manufacturing -(succeeded in oding so)	To support logistics processes at Port environment, via 5G, video analytics and AI we had to equip Port assets, and in particular Cranes and Trucks, with high resolutions cameras. Specifically for the case of cranes, any modification to the crane is prohibited by the manufacturer. We had to come up with solutions for camera placements on top of the cranes that make sense for the AI services, but also that do not affect at all the crane design, and intent, as provided by the manufacturer
	Cost				In regard the parking video application developed by Vodafone the cost lies only on the server, considering that users (drivers) have 5G enabled mobile phones and no other hardware needed.
	Business model not clear				
Capacity building					

**Table 10: Answers from Living labs regarding policy framework 2**



## Annex 3: Interview questions

The interview document was prepared with the following questions:

### Information about the respondent:

1. In which Country is your organisation located?
2. Are you currently involved (or have you been involved) in any initiative that deals with the applications of 5G technologies, Artificial Intelligence, Big Data, Internet of Things, and Autonomous vehicles, or similar in logistics and supply chain and in the port domain?

If yes, please provide a brief description of the context:

3. Is your organization involved in any of the 5G--LOGINNOV Living Labs?

If yes, which one?

- Athens
- Hamburg
- Koper

4. Are you and/or have you been a Partner of any 5G-PPP Project?

If yes which one?

5. Are you and/or have you been a Partner of any H2020 or Horizon Europe or CEF project linked to transport and logistics topics?

### GDPR consent

6. Do you agree that we mention your name as contributor for the interview?
7. Do you agree that we publish the interview results in the related deliverable for the 5G - LOGINNOV Consortium?

### Relevance

8. How does the topic relate to roadmaps?
9. What are your current initiatives – Status you observe?

The following question addresses your perspective on the gaps that 5G-LOGINNOV identified for EU transferability and formulate common recommendations towards public authorities and EU commission.

The gaps identified were grouped in 6 categories:

- Technical gaps
- Infrastructure and installation gaps
- Regulatory topics
- Administrative issues
- Training and expertise
- Business models

10. Do you encounter similar issues?

11. Can you elaborate or give examples on the issues, problems that you have encountered related to these gaps?

### Your potential engagement

12. How can your organisation help in deployment of the 5G -LOGINNOV innovations?

13. Do you recognise the policy recommendations — anything missing from our side?

## Annex 4: Interview notes I

### 5G-LOGINNOV policy recommendations - ALICE inputs-Meeting

The interview focused on policy recommendations to support the implementation of 5G technologies and related innovations in the logistics and port domains.

The interview covered the following key points:

1. **5G Technologies and Innovation in Logistics:**

- ALICE is involved in activities related to 5G applications and artificial intelligence (AI) for logistics through their thematic groups.
- ALICE has organized collaborative innovation days that brought together projects like 5G-LOGINNOV, ALICE, and others to exchange information and facilitate connections.

2. **Participation in Projects:**

- ALICE has participated in projects related to logistics and 5G, such as PIONEERS and MOOD. However, they were not directly involved in 5G-LOGINNOV or other living labs due to their policy at the time of project funding.

3. **Relevance to ALICE's Roadmaps:**

- ALICE's interest in 5G technologies lies in its potential to enhance real-time visibility and management of logistics operations, contributing to efficiency, resiliency, and safety.
- The potential for automation enabled by 5G is acknowledged, but its practicality and business models are still evolving and not yet well-defined.

4. **Challenges and Considerations:**

- ALICE highlights the need for clearer business models around 5G-enabled automation and proprietary networks.
- Challenges related to security, standardization, and regulatory aspects are recognized and need to be addressed for successful deployment.

5. **Policy Recommendations:**

- Policy recommendations focus on ensuring the priority rollout of 5G networks in port areas and the hinterland to support efficiency and resiliency.
- Enhanced research, development, and deployment of AI applications for optimal logistics and port operations are recommended.

This interview aimed to gather insights into the challenges, opportunities, and policy implications surrounding the implementation of 5G technologies in the logistics and port sectors. The discussion helps to enrich the understanding of how these technologies intersect with ALICE's objectives and priorities.

1. **Market Uptake and Development:** there was an expression of uncertainty about whether 5G technology is sufficiently developed for broad market uptake. While proprietary 5G networks are being tested in various ports, there's uncertainty about the return on investment for these implementations.
2. **Use Cases and Visibility:** use cases like operations visibility are significant in the context of 5G adoption. It was also mentioned that the visibility of 5G networks has increased in ports and cities, indicating progress.
3. **Technical Gaps:** cannot provide specific technical details on identified gaps, suggesting that they might be more appropriately discussed by another colleague.
4. **Investment and Infrastructure Costs:** There is an acknowledgement of investment costs related to 5G infrastructure and suggestion that cost and business models are important considerations.
5. **Capacity Building and Knowledge Sharing:** it was recommended to combine the results of various 5G PPP projects in logistics to create an overview of potential applications and use cases. This will increase awareness and understanding of the technology's capabilities.
6. **Deployment of Innovations:** partnership can assist in deploying 5G logistics innovations through their online and offline networks, promoting the innovations to potential partners.

7. **Cloud Report and BoostLog Project:** the BoostLog project, a cloud report on vital technologies applications in logistics, and how the conclusions from 5G-LOGINNOV's work can contribute to this report.
8. **Customization and Replicability:** it was highlighted that the challenge of customizing solutions to different port environments, leading to scalability and replicability issues. And it was suggested that working on overarching solutions to minimize customization requirements was important.
9. **Regulation and Industry Standards:** emphasize the need for industry standards and openness in solutions to avoid vendor lock-in and ensure interoperability.
10. **Policy Recommendations:** there is progress in 5G network deployment, but more exploration is needed for AI applications, while regulatory support might be necessary, industry standards are crucial.

#### **Additional Points:**

- The collaboration with 5G-LOGINNOV and their open approach to knowledge sharing was praised. There is progress in 5G network deployment and visibility in port areas.
- It is important to create a unified database for policy recommendations and test results, as it will help in sharing and accessing information.

Some insights were shared on various gaps related to the deployment and adoption of 5G technology in the context of logistics and port operations. These gaps align with the technical, regulatory, and business aspects identified in internal workshops. The inputs are summarized below:

1. **Technical Topics:**
  - No specific technical gaps were mentioned in this conversation, but an acknowledgement was made.
2. **Infrastructure and Installation:**
  - Need to address customization challenges when implementing 5G solutions in different port environments. Solutions often require extensive customization for each deployment, leading to scalability and replicability issues.
3. **Cost:**
  - The importance of considering cost and business models when deploying these solutions.
4. **Regulatory Topics:**
  - Emphasis on the significance of industry standards and open solutions. Regulation can play a role in ensuring interoperability and openness.
5. **Administrative Issues:**
  - Not directly addressed.
6. **Training and Expertise:**
  - Combining the results of various 5G PPP projects in the logistics domain to create a comprehensive overview of potential applications and use cases. This would increase awareness and understanding of 5G's capabilities, indirectly highlighting the importance of training and expertise dissemination.
7. **Business Models & Enablers:**
  - The are customization challenges in implementations indirectly touch upon business models and enablers. Overcoming the need for extensive customization could potentially lead to more scalable and economically viable business models.

## **Annex 5: Interview notes II**

### **5G-LOGINNOV policy recommendations - CCAM inputs-Meeting**

During the interview various key points were discussed regarding policy recommendations aimed at optimizing freight and traffic operations at ports and logistics hubs through innovative technologies. The focus was on two specific policy frameworks:

#### **1. Priority Rollout of 5G Networks in EU Hinterland and Port Areas:**

- The project aims to emphasize the deployment of 5G networks in port and hinterland areas, as opposed to just major cities for consumer purposes.
- Challenges were highlighted in the smooth implementation of 5G technologies in various living labs, which hindered their deployment.
- The objective is to engage public authorities in formulating policies that address these challenges and promote the widespread and efficient deployment of 5G networks in logistics areas.
- The outcome of this policy would be improved connectivity, enabling advanced applications and services for enhanced logistics operations.

## 2. Enhancement of AI Applications for Optimal Logistics:

- The focus here is on developing, deploying, and utilizing AI applications to enhance logistics, supply chain management, and port operations.
- It was noted that while AI is advancing rapidly, its application in logistics and port operations is still at an early stage, primarily limited to image recognition and related services.
- The objective is to accelerate the research, development, and deployment of AI solutions that cater specifically to the needs of the logistics sector.
- The policy recommendations target fostering a more robust ecosystem for AI implementation in logistics and port operations.

The interview highlighted the significance of these policy recommendations, which aim to bridge existing gaps and challenges in technology adoption within the logistics and port industry. The project seeks to collaborate with stakeholders and other associations to advocate for these policies and facilitate their implementation. The policy documents being developed will provide a comprehensive framework outlining the reasons behind each policy and suggesting concrete actions for the EU Commission to undertake.

Overall, the interview underscored the need for proactive policy measures to expedite the deployment of 5G networks and AI applications in the logistics and port sectors, thereby promoting efficiency, connectivity, and innovation within these crucial areas.

- **Technology and Services Focus:** Emphasizing logistics as a critical sector.
- **Involvement in Initiatives:** Modi project was mentioned and also the importance of aligning technology investments with logistics activity in areas such as the port of Gothenburg and the corridor to Hamburg.
- **Stakeholder Role:** technology-agnostic approach, considering both 5G and LTE for services, with a focus on assessing the true benefits of 5G in terms of cost-effectiveness and the advantages it brings.
- **Collaboration and Common Message:** The importance of creating a common message among different projects and stakeholders, emphasizing the deployment of technologies in areas where logistics is active, was highlighted. Collaboration between projects like Modi and the idea of linking corridors, hubs, ports, and terminals were discussed.
- **Relation to Development Maps:** The connection between the discussed topics and development roadmaps was explored. Confined automation areas were mentioned and the benefits of such technology for port and terminal operations were identified. The potential to increase productivity, safety, and efficiency while adhering to regulatory frameworks and policy was discussed.
- **Technical Gaps:** Performance-to-cost ratio of equipment and issues related to network reliability, maintainability, and availability. There are also challenges in border crossings, handovers between operators, and maintaining low latency in port areas.

- **Administrative and Regulatory Challenges:** There are administrative challenges arising from the involvement of various actors, operators, and logistics companies within port operations. The need for standardized practices across different ports to streamline processes and reduce complications was highlighted. Regulatory topics, including standardization and harmonization, were also considered important for effective deployment.
- **Training and Expertise:** The importance of continuous training and sharing best practices for various roles within the port environment, including operators, maintenance staff, and truck drivers, was emphasized. Challenges related to language barriers and varying skill levels were also mentioned.
- **Infrastructure Installation:** Challenges in infrastructure installation, such as antenna placement, power availability, and network access, were discussed. The need for best practices and harmonized approaches in this aspect was recognized.
- **Business Models:** The interview touched on the emergence of new business models and actors within the port environment due to technological advancements. There are complexities in dealing with multiple stakeholders and finding profitable margins.
- **Policy Recommendations:** support for policy recommendations presented by the project was expressed, particularly emphasizing harmonization across different ports and the need for clear regulations and priorities.
- **Engagement and Collaboration:** The CCAM partnership could serve as a platform for ongoing projects to present results and discuss opportunities, risks, and challenges related to connectivity and 5G. Potential for collaboration with other partners was highlighted, including those engaged in the ARCADE project.
- **AI and Automation:** The discussion touched on AI and automation, recognizing the need for common terminology, definitions, and evaluation methodologies to effectively implement AI solutions in port logistics.

Overall, the interview highlighted automation as an early adopter area and the potential benefits it brings to productivity and safety within port areas were notable takeaways from this segment of the interview. The interviewee provided valuable insights into various gaps and challenges in deploying 5G and AI technologies in port operations. The importance of standardized practices was emphasized, as well as regulatory harmonization, and continuous training to ensure successful implementation.

As a summary, this is what has been said according to the gaps found from the internal workshops:

#### **Technical Topics:**

- Need for reliability and maintainability of equipment.
- Challenges in border crossings and handovers between operators were noted, emphasizing the importance of low latency in port areas.
- Availability of network technology and power for infrastructure installations was discussed as a challenge.

#### **Infrastructure and Installation:**

- Challenges in infrastructure installation, such as antenna placement, power availability, and network access, were recognized.
- Standardized practices and harmonized approaches for infrastructure deployment were considered crucial.

#### **Cost:**

- Cost-effectiveness in implementing technology solutions.
- Performance-to-cost ratio of equipment and availability of technology were discussed as potential challenges.



**Regulatory Topics:**

- Regulatory aspects were highlighted, including the need for standardization and harmonization across different ports.
- Clear regulations and priorities for deploying technology solutions were deemed important.

**Administrative Issues:**

- Challenges arising from the involvement of various actors, operators, and logistics companies within port operations were acknowledged.
- Streamlining processes and reducing complications through standardized practices across different ports was emphasized.

**Training and Expertise:**

- Continuous training and sharing best practices for various roles within the port environment were emphasized.
- Challenges related to language barriers and varying skill levels were recognized.

**Business Models & Enablers:**

- The emergence of new business models and actors within the port environment due to technological advancements was discussed.
- The need to address complexities in dealing with multiple stakeholders and finding profitable margins was highlighted.

**Collaboration and Engagement:**

- CCAM partnership as a platform for projects to discuss opportunities, risks, and challenges related to connectivity and 5G.
- Collaboration with other partners, including those engaged in the ARCADE project, was considered beneficial.

**AI and Automation:**

- AI and automation were discussed, emphasizing the need for common terminology, definitions, and evaluation methodologies for effective implementation in port logistics.

To summarise, insights were provided into technical, infrastructure, cost, regulatory, administrative, training, and business-related aspects of deploying 5G and AI technologies in port operations. The inputs highlighted challenges and opportunities in various domains while emphasizing the importance of harmonization, standardized practices, and collaboration within the industry.





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