5GLOGINNOV

Deliverable 5.5

Exploitation report

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Authors	M. Apruzzese (ICOOR) P. De Gregorio (ICOOR) S. Musso (ICOOR)
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List of abbreviations and acronyms

Abbreviation	Meaning
5G	5th Generation (of broadband cellular networks)
5G-NSA	5G Non-Stand Alone
5G PPP	5G Public-Private Partnership
5GMF	Fifth Generation Mobile Communication Promotion Forum
AI	Artificial Intelligence
AR	Augmented Reality
ATP	Automated Tuck Platooning
B2B	Business to Business
CAD	Connected Automated Driving
CAM	Connected Automated Mobility
CAWI	Computer Aided Web Interview
CCAM	Cooperative, connected, and automated mobility
CCTV	Closed Circuit Television
EASA	European Union Aviation Safety Agency
E2E	End-to-End
eMBB	enhanced Mobile Broadband
ETSI	European Telecommunications Standards Institute
GDPR	General Data Protection Regulation
GLOSA	Green Light Optimal Speed Advice
IaaS	Internet as a Service
IA/RIA	Innovation Action/Research and Innovation Action
IoT	Internet of Things
IT	Information Technologies
ICT	Information and Communication Technologies
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
ITU-R	International Telecommunication Union – Radio communication sector
KER(s)	Key Exploitable Result(s)
KPIs	Key Performance Indicators
LCMM	Low Carbon Mobility Management
LL(s)	Living Lab(s)
ML	Machine Learning
MEC	Multi-access Edge Computing
mMTC	massive Machine Type Communication
NB-IoT	Narrow Band Internet of Things
NFV-MANO	Network Functions Virtualization MANagement and Orchestration
OEMs	Original Equipment Manufacturers

PCT	Piraeus Container Terminal
PG	Promotion Group
QoS	Quality of Service
RRM	Radio Resource Management
RTPORT	Real Time Port
SA	Stand Alone
SME	Small Medium Enterprise
TRL	Technology Readyness Level
UC(s)	Use case(s)
URLLC	Ultra-Reliable Low Latency Communication
VR	Virtual Reality
WP	Work Package

EXECUTIVE SUMMARY

The 5G-LOGINNOV Project designed an innovative framework addressing the integration and validation of CAD/CAM technologies related to the ports domains by creating new opportunities for logistics value chain innovation. Thanks to the new advanced capabilities of 5G relating to wireless connectivity and core network agility, the 5G-LOGINNOV Living Labs aimed not only to significantly optimise their operations but also to minimise their environmental footprint to the city and the disturbance to the local population. 5G-LOGINNOV is also expected to be a catalyst for market opportunities build on 5G core technologies in the Logistics domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SMEs and Start-Ups. The current document provides the outcomes of the assessments performed within the project Task 5.3 « Exploitation», during which the exploitation framework has been defined, monitored, and implemented.

First, this deliverable describes the context of each Living Lab (LL) - Athens, Hamburg, Koper - highlighting the main Key Exploitable Results (KERs) and the linked exploitation plans. The LLs' exploitation strategy has been clarified, by providing the strategic recommendations and identifying potential stakeholders, benefits, strategies for new actors, and barriers with mitigation actions for the exploitation of solutions beyond the 5G-LOGINNOV project. In the project, **10 technological results have been defined as Key Exploitable Results:** 4 were generated in the context of the Hamburg Living Lab, 4 in the Athens Living Lab and 2 in Koper. These results empower the Living Labs to innovate and implement advanced logistics solutions, improving efficiency, safety, and sustainability across various domains. The list below summaries these KERs.

- **A.1: 5G and IoT Platform in Port Operations** (Athens LL): a network management and service orchestration platform, focusing on automatic AI/ML software deployment tailored to ports.
- **A.2: 5G&AI-enabled container seal detection for supporting logistics process** (Athens LL): a cargo container seal detection system that utilizes 5G&AI video analytics, ensuring container content integrity and liability verification.
- **A.3: 5G&AI-enabled Human Presence Detection** (Athens LL): a system providing AI/ML-based video analytics for collision avoidance and security, packaged as cloud-native network functions at the edge.
- **A.4: 5G Truck Fleet Management Platform** (Athens LL): a platform facilitating parking with real-time video communication, utilizing 5G mobile phones for live video feeds among trucks.
- **H.1: 5G enabled Floating Truck Emission Data (FTED)** (Hamburg LL): a system that collects data from trucks to quantify carbon emissions and driving behavior and that allows a linkage between speed profiles to standard driving cycles.
- **H.2: 5G enabled GLOSA** (Green Light Optimal Speed Advice (Hamburg LL): a system providing drivers with speed recommendations at intersections, aiming to avoid collision and improving safety.
- **H.3: 5G enabled Collision Warning** (Hamburg LL): a system that sends collision alerts to vulnerable road users, facilitating the platooning vehicles.
- **H.4: 5G enabled Carbon Emission Trading** (Hamburg LL): a tool that tracks carbon emissions in logistics and provides a quantification of the impact of traffic management activities.
- **K.1: Improved Private 5G Mobile System** (Koper LL): a customized network and and set of services aiming to meet specific business needs.
- **K.2: Improved Industrial IoT System** (Koper LL): a technology based on an upgraded hardware platform to ensure a secure, resilient, and QoS guaranteed 5G connectivity

The business recommendations, gathered in this document, collectively provide a comprehensive roadmap for the future development, implementation, and exploitation of 5G and related technologies in port and logistics operations across the three Living Labs. In summary, the common points across the three Living Labs highlight a **shared vision of leveraging 5G technology and complementary innovations to enhance port and logistics operations, improve safety and security**, **and align with sustainability goals**. They will also emphasize the importance of collaboration with stakeholders and proactive measures to overcome potential challenges. The exploitation strategy has been defined at the level of each Living Lab, since most technological KERs foresee a joint exploitation strategy between the LLs' actors. In addition, since the 5G-LOGINNOV project has engaged, in each LL, the winners of the 5G-LOGINNOV Open Call for Innovative Start-ups, the exploitation strategy includes the recommendations for these new actors in the post-project phase.

The document includes the results of a transferability analysis for the ten KERs validated at the three Living Labs. The analysis was conducted through a survey distributed to EU logistics stakeholders from February 2023 to September 2023. The survey targeted a diverse group of logistics and telecom stakeholders, including both large and small players from the public and private sectors. A total of 34 respondents participated, representing various sectors and geographical areas. The survey revealed that several technologies validated in the Living Labs were considered potentially transferable to other context: it resulted that **the most interesting technologies** are the **K.1: Improved private 5G mobile system for use cases in port and logistics domain (Koper)**, the **K.2: Improved Industrial IoT System" (Koper),** the **A.1: 5G and IoT Platform in Port Operations" (Athens),** the **H.1: 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems" (Hamburg)** and the **H.2: 5G enabled GLOSA" (Hamburg).** The survey found that external stakeholders are motivated to adopt these technologies for several reasons, including enhancing safety and security, improving operational efficiency, reducing costs, promoting environmental sustainability, and fostering digital innovation and collaboration within the port ecosystem. However, there are significant challenges and blockers to scaling up these technologies. These include the high infrastructure investments required for 5G implementation, potential reluctance from customers to embrace new technologies, complex implementation processes, and regulatory differences across regions. Some technologies also struggle to demonstrate their value proposition, and concerns exist about their suitability for the complex port environment. To enable the scaling up of these technologies, critical success factors include establishing cooperation or federations among logistics operators to create a digital port ecosystem, fostering digital innovation within the port, engaging in lobbying activities with governmental institutions, and having access to real-time and large-scale data processing capabilities.

Then, this document describes those that are defined as "**Horizontal" KERs** as they are **not tied to technologies related to specific LL** but **linked to the parallel research activities**. These "Horizontal" KERs constitute valuable resources with the potential to shape the future of 5G technology in logistics and transportation. They embody a commitment to collaboration, innovation, and knowledge-sharing, ensuring the enduring impact of the 5G-LOGINNOV project beyond its conclusion. The five "Horizontal" KERs generated during the project are the following:

- P.1: Data Handling Procedures: the set of procedures used in the 5G-LOGINNOV project to ensure secure and effective data management, addressing access, storage, sharing, and disposal, with a focus on personal data.
- P.2: Evaluation Methodology: the approach used to assess the impacts of 5G-LOGINNOV Use Cases.
- P.3: 5G-enabled Products & Services Register: the catalog of solutions used in each LL complemented by other products and services available on the market.
- P.4: Network of 5G-enabled Start-ups and Innovative Players: the group of new actors (SMEs and start-ups) that have been gathered and engaged during the project.
- P.5: 5G-LOGINNOV Position Papers: the recommendations to key stakeholders, including the lessons learnt by the 5G-LOGINNOV project.

Finally, this deliverable considers the main impacts on each project partner, with emphasis on the main results achieved and how these results will be further exploited. 5G-LOGINNOV **has been a success for all project partners**, offering various benefits such as **enhancing internal capabilities** and **acquiring new services** that provide a **competitive edge.**
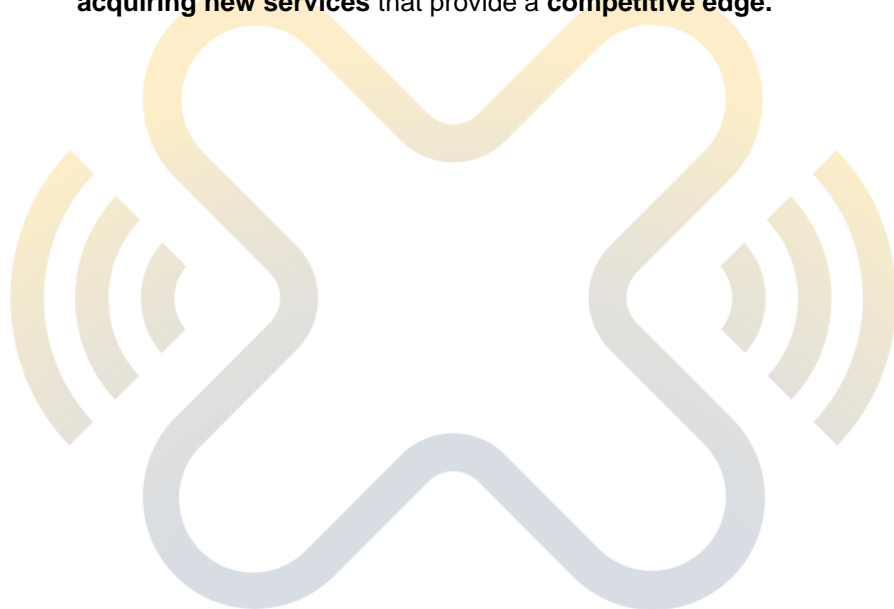
1   INTRODUCTION

1.1   Project introduction

5G-LOGINNOV will focus on seven 5G-PPP Thematic and support to the emergence of a European offer for new 5G core technologies in 11 families of use cases. 5G-LOGINNOV main aim is to design an innovative framework addressing integration and validation of CAD/CAM technologies related to the Industry 4.0 and ports 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 Internet of Things 5G devices, data analytics, next generation traffic management and emerging 5G networks, for city ports to handle upcoming and future capacity, traffic, efficiency, and environmental challenges. 5G-LOGINNOV will deploy and trail 11 families of use cases 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 domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SMEs and Start-Ups. 5G-LOGINNOV will foster the integration of SMEs and Start-Ups in new markets using its three Living Labs as facilitators and ambassadors for innovation on ports. 5G-LOGINNOV promising innovations are key for the major deep-sea European ports in view of the mega-vessel era (Hamburg, Athens), and are also relevant for medium sized ports with limited investment funds (Koper) for 5G.

1.2   Purpose of the deliverable

The objective of this deliverable is to describe the 5G-LOGINNOV Exploitation Report. Therefore, the deliverable aims to define the final exploitation strategy and main Key Exploitable Results (KERs). The objectives related to this deliverable have been achieved in full and as scheduled.

1.3   Intended audience

This deliverable is public and therefore any stakeholder interested in the 5G-LOGINNOV exploitation strategy can make use of it. It is specifically addressed to the 5G-LOGINNOV partners to be used as a reference for their exploitation activities beyond the 5G-LOGINNOV project duration.

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

This deliverable is the primary source of information for the project partners' exploitation activities. The document is structured as follows:

- Section 2 explains the exploitation framework adopted in each LL.
- Section 3 provides the results of the transferability assessment.
- Section 4 delivers the exploitation strategy for "Horizontal" KERs.
- Section 5 describes the exploitation report for each project partner.
- Section 6 presents the main recommendations and conclusive remarks.

In Annex 1, the transferability survey can be found and in Annex 2 the main changes in partners results (compared to D5.4) are listed. Annex 3 provides the full list of individual results, including a brief description, the application area and the exploitation route defined for each result.

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

- The products and services register developed within the continuous market analysis in task T4.1 ("Strategy supporting next generation logistics operations") has been consulted.
- Task 4.3 ("Boosting economic opportunities") defines the business models of the LLs, that have been used as a baseline to develop the future strategies provided in this document.
- Task 5.4 ("Standardisation and Spectrum") will refer to this document to verify if any standard will be used by or generated through KERs.
- This document provides the main results for which IPR agreements are defined in T6.3.

2 EXPLOITATION STRATEGIES LINKED TO THE 5G-LOGINNOV LIVING LABS

5G-LOGINNOV provided the three Living Lab (Athens, Hamburg, Koper) with the possibility to develop and implement innovative logistics applications thanks to the usage of the 5G-enabled network.

In this chapter, the Exploitation Report of each LL within the 5G-LOGINNOV project (Hamburg, Athens, and Koper) is presented. They have made significant strides in harnessing the potential of 5G networks and complementary technologies to improve port operations. The report outlines the achieved Key Exploitable Results (KERs), the strategies for the future uptake of 5G-enabled innovation in the LLs' areas, and the stakeholders who stand to benefit from these innovations. This section also includes the recommendations for the new actors that have been engaged through the 5G-LOGINNOV Open Call for Innovative Start-ups and the potential barriers for exploitation for each LL. Section 2.1 focuses on the Hamburg LL, section 2.2 on Athens LL and section 2.3 on Koper LL.

2.1 Exploitation Report of the Athens Living Lab

2.1.1 Summary of Key Exploitable Results (KERs) of the Athens Living Lab

In the Athens Living Lab, four Key Exploitable Results (KERs) have been defined as mostly relevant, since they relate primarily with the optimization of logistics operations and with the improvement of human safety within the port's area. The KERs defined within the Athens Living Lab are:

- **A.1: 5G IoT Platform in Port Operations**. It is a technology suite that combines the power of 5G networks along with extreme-edge and cloud computing services and port infrastructure elements, for efficient delivery of AI services to support logistics and safety applications. It leverages the high-speed, low-latency, and reliable connectivity provided by 5G networks to enable seamless communication and data transfer between 5G enabled devices (5G-Trucks, 5G-Cranes, 5G-IoT nodes) deployed within a port environment.
- **A.2: 5G&AI-enabled container seal detection for supporting logistics process**. It is an AI-assisted video analytics service for automating the seal check process at containers arriving and departing at and from PCT, during loading and unloading operations of vessels. This service exploits the 5G-IoT platform described in KER A.1.
- **A.3: 5G&AI-enabled human presence detection to support safety/security operation**. It is an AI-assisted video analytics service for human presence detection targeting safety applications (e.g. people detection in proximity to trucks or cranes) exploiting fixed or mobile cameras mounted on vehicles, or security/privacy operations (e.g. people detection in restricted/prohibited areas), within the port premises. This service exploits the 5G-IoT platform described in KER A.1.
- **A.4: 5G Truck Fleet Management Platform.** This KER regards the design and the implementation of the 5G-IoT platform defined in A.1 including software and hardware components. It takes the bird-eye-view parking concept of vehicles into a new level by leveraging a 5G video feed from other vehicles. The scenario uses the concept of video teleconference but implemented for truck drivers. Each truck is fitted with a 5G based mobile phone with the front camera facing the street, and then the camera feed is broadcasted, along with location info, real time to the adjacent truck (installed mobile phones). This gives an additional surrounding live video and the ability for a driver to view the truck while manoeuvring during parking.

Table 1 resumes the activities carried on during the 5G-LOGINNOV project for the exploitation of each KER and the strategies that will be adopted by the stakeholders for ensuring the further uptake.

Ker ID	Ker name	Exploitation report	Future plans
A.1	5G IoT Platform in Port Operations	The private port infrastructure at Piraeus port, a real industrial setting, was used to validate and test the 5G network, IoT platform (including cloud/edge computing, management and orchestration, AI/ML, etc.) and services under realistic network conditions and daily workloads of the port's operations. The evaluation provided the partners with a realistic picture of the technology suite capabilities and limitations in today's 5G deployments when tested against the demands of modern port operations.	Further investment in the ecosystem of 5G and beyond technologies, pursuing also other research initiatives relevant to maritime and logistics, e.g. IA/RIA Project proposals under the Smart Networks and Services Joint Undertaking (SNS JU).
A.2	5G&AI-enabled container seal detection for supporting logistics process	The service and the network performance requirements implemented in the context of A.2 and A.3 (such as bandwidth and AI related key performance indicators e.g. inference accuracy) were validated and tested in real network conditions and realistic daily workloads at the port of Piraeus.	A.2 and A.3 will be further developed and enhanced to support industrial grade services, in daily port operations. An activity already underway is to further train the AI services to increase the accuracy of the predictions provided by the ML service. The service will be verified with internal protocols according to the standard practices of the port to assess further the business potential of the service; and confirm/verify its wide adoption and uptake in daily operations.
A.3	5G&AI-enabled human presence detection to support safety/security operations		
A.4	5G Truck Fleet Management Platform	This KER has been exploited in the context of the Athens LL UCs tests, in the port of Piraeus.	This KER will be further developed and used by the Port of Piraeus.

Table 1: KERs of the Athens LL

2.1.2 Business recommendations for the future uptake of solutions

The Athens Living Lab has made significant progress in its mission to harness the power of 5G networks. The future focus remains firm, centred on the development and testing of innovative solutions designed to revolutionize real-time tracking, enhance visibility of yard vehicles, optimize service delivery, streamline job allocation, and enable predictive maintenance.

The future strategy shall be based on the following key drivers :

- **Unpacking the tested business models in a unique value proposition**. The common value proposition revolves on data exchange platforms and protocols between vehicles, infrastructures, and port's personnel. The primary objective relies in the optimisation of port operations and resource planning, while improving the working and safety conditions for the port's personnel. Companion technologies should be continuously adopted and integrated with the 5G network, such as IoT sensors and high-definition cameras installed on vehicles and infrastructures. In this scenario, the

role of the 5G network will be to allow a real-time and low latency collection and exchange of information.

- **Pushing the digital transformation of the Port Ecosystem**. Real-time data directly collected from the field can be analysed through AI and ML algorithms and techniques to optimise the port processes, specifically the loading and unloading process of vessels. Moreover, the analysis of high-definition videos from the port area allows the detection of potential cases of injuries or potential accidents (safety improvement for port personnel), the detection of humans in non-allowed areas (thus improving the security conditions in the port areas), and the detection of potential sources of non-compliance in the port processes. Furthermore, the flexibility of the implemented technologies opens doors to future customization, tailoring solutions to the specific needs of each port facility.

- **Including all critical resources and activities in the overall planning**. Besides the deployment of the 5G network to facilitate real-time data exchange, the development, training and testing of AI-enabled systems can be used to analyse the collected information and extract valuable outcomes from them. The high-definition cameras for the collection of images must be installed on vehicles and port infrastructures and integrated with existing ICT infrastructures. Considering these requirements, forging partnerships with ICT providers and Mobile Network Operators (MNOs), as well as yard machinery suppliers becomes paramount.

- **Leveraging costs savings as revenue streams**. The main sources of revenues after the end of the 5G-LOGINNOV may come from usage fees and licenses paid by potentially interested actors and stakeholders. However, it is important to highlight that a primary source of revenues deals with cost savings coming from enhancing and augmenting port operations and processes (e.g., service automation through AI/ML) and of the infrastructures usage (increase of the service life for yard vehicles, as well as the reduction of failures and of downtimes for maintenance), with positive impacts on maintenance costs, and indirect benefits on the effectiveness of the operation planning (relying on more efficient vehicles and infrastructures). Moreover, another indirect impact is the increase of the quality of work for the yard personnel, with reduction of stress and improvement of safety (social benefits).

2.1.3 Impacted stakeholders' categories and potential benefits

The following table lists the main stakeholder's types that may benefit from the Hamburg Living Lab results.

Stakeholders' groups	Potential benefits
Port authority	• Increased efficiency of the port processes and activities • Increased control of the yard activities • Predictive maintenance for yard machineries (potential reduction of maintenance costs and spare parts warehouses, reduction of downtimes, increase of the vehicles' lifetime) • Increased safety and security in the port areas • Improved integration between different port functions (e.g., operations, custom, HR management, fleet management, etc.)
Port operations Managers	• Improved planning of the port activities • Increased visibility of the logistics chain • Optimisation of the resource usage • Real-time detection of potential sources of non-compliance
Port/yard personnel	• Optimisation of the workflow and improved working conditions (reduction of work-related stress) • Reduction of risks and potential injuries • Increased visibility on port operations and optimisation of the activities
Public authority - Municipality	• Increased safety and security for workers and reduction of the potential sources of injuries (social cost) • Optimisation of the traffic flow in port and surrounding areas

• Reaching local, national, and European sustainable goals (traffic congestion and air pollution)	

Table 2: Stakeholders and potential benefits: Athens LL

2.1.4 Barriers and mitigation actions

Ports are critical infrastructural hubs with diverse and complex operations, and while AI video analytics can offer many benefits in optimizing these operations, there are several holdbacks that can hinder its wide adoption.

- **Data Privacy and Security**. Several use cases in Athens LL are based on AI-assisted video analytics services, exploiting high resolution video footage from surveillance cameras installed in various areas within the port. Surveillance concerns for workers and visitors due to the continuous monitoring of such areas can raise privacy issues. In the Athens pilot the discussed services exploit the video frames as input for the AI service and send respective alerts (according to the use case needs), but do not store any video footage. The system however can be parametrized to do so. In such cases standard Gaussian blurring techniques are to be used to hide characteristics of e.g., a person. Presenting the system's functionalities and privacy related protection mechanisms, as well as its advantages (reduced environmental impact, improved safety, and cost-efficiency) in daily port operations can help build trust in the service, in what concerns also privacy issues.
- **Reliability and Accuracy.** AI based services need to be highly reliable, i.e., provide confident inferences. Any false positives or negatives can have significant consequences, including liability fees, e.g., failure in detecting the presence (false positive) of container seal (KER A.2), unnecessary interruption of port operations (KER A.3), e.g., person detected in proximity to truck although not present (false positive), or potential injuries, e.g., person not detected in proximity to truck although present (false negative). Hence, investment in the continuous training and augmentation of the AI services (e.g., with more data such as video frames) that capture more information regarding a port ecosystem (with various equipment, containers, vessels, and personnel operating simultaneously) will increase the inference accuracy of the services, and thus its potential uptake in daily port operations.
- **High Initial Investment:** Deploying AI video analytics in ports requires substantial investments in cameras, servers, network infrastructure, software, and training. Highlighting the benefits for such investments (e.g., reduced environmental impact, improved safety, and cost-efficiency) to the relevant stakeholder community (technology providers, regulatory bodies, port authorities, and workers), ensuring continuous feedback and improvements can help in the successful adoption of AI video analytics services at ports.

2.1.5 Exploitation strategies for new actors involved in the Athens Living Labs

The new company involved in the Athens Living Lab thanks to the 5G-LOGINNOV Open Call for Innovative Start-ups is Libra AI that proposed the Real timE drowSiness detectiON, AlerTing and rEporting (RESONATE) solution. This is an innovative and low cost system for the detection of the drowsiness of the drivers, with positive impacts on the safety and security conditions in the port area and on the improvement of the working conditions of the port personnel.

2.1.5.1 Exploitation opportunities for Real timE drowSiness detectiON, AlerTing and rEporting (RESONATE)

Driver drowsiness is one of the leading causes of motor vehicle crashes. The development of drowsiness detection technologies is both an industrial and a social challenge. Notably, the existing safety systems that detect drowsiness are not widespread and are uncommon among drivers because they are generally available in luxury vehicles. An increased embedding and connecting of smart devices equipped with sensors and mobile operating systems, such as Android, which is installed as an operating system in several cars, is the current trend in automotive sector. In addition, machine learning

has made ground-breaking advances in recent years, especially in deep learning. Thus, using these new technologies and methodologies can be an effective way to increase the efficiencies of the existing real-time driver drowsiness detection systems and provide a tool that drivers can widely use.

In this context, the involvement in the 5G-LOGINNOV project acts as a very important chance to test the RESONATE tool in a real logistics environment, with the aim to evaluate its applicability in the logistics sector. The 5G network implemented in the port of Athens is an important facility to test the most suitable characteristics of the communication network, to ensure the real time data exchange from servers and vehicles.

After the testing phase occurred in the Athens Living Lab during the 5G-LOGINNOV project, the solution can be widely adopted in the market, also fostering the results of a real use case to communicate its effectiveness and low impact (at driver level). The partners of the 5G-LOGINNOV consortium can increase the development and test phase of the solution, providing valuable insights on the port environment, as well as on policies and requirements regulating the logistics activities. Beyond the end of the project, the same consortium can act as an exploitation channel to foster the market adoption of the RESONATE tool. Moreover, the solution developed and tested in the Living Lab potentially acts as an accelerator for the commercialisation and market penetration, providing a useful success story for future exploitation activities, as well as useful outcomes to overcome potential barriers to adoption (e.g., GDPR and data protection policies and regulations).

To increase the awareness of the solution among the potential customer targets, collaboration with public bodies (e.g., Transport Ministries) will be vital to highlight the importance of drowsiness detection in the health and social context. Furthermore, insurance companies can be interested in fostering the adoption of the RESONATE solution among their customer, to increase the level of safety and reduce the probability of incidents and injuries. Other potential customer targets of RESONATE are the automotive companies, potentially interested in embedding the innovative system in their products, making them more attractive for their end users.

2.1.5.2 Key Recommendations for the exploitation of new actors' solutions

Some key recommendations are provided, in order to push the exploitation of the company' products.

- **Target Fleet Managers and Professional Drivers**. Fleet managers are the most promising potential targets of this solution, with direct impacts linked to the improvement of safety for drivers and reduction of costs related to incidents and injuries. For the same reason, professional drivers are another potential customer target.
- **Explore Automotive Industry Collaboration.** Collaborations with OEMs can be beneficial, as these entities may be interested in integrating the innovative RESONATE system into their products. Emphasizing the system's affordability and simplicity can align with their product strategies.
- **Ensure economic sustainability by offering flexible pricing models**. More strategies can be considered to get revenues, such as direct sales of the system or a pricing model based on usage and licensing fees. This flexibility can cater to different customer preferences and business models.

2.2 Exploitation Report of the Hamburg Living Lab

2.2.1 Summary of Key Exploitable Results (KERs) of the Hamburg Living Lab

In the Hamburg Living Lab, four main KER have been defined, mainly addressing data collection, traffic management and emission monitoring scopes. The four KERs defined for the Hamburg Living Labs are:

- **H.1: 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems**. FTED consists of collecting speed profiles, linking them to the driving reference cycle (WLTP) and measuring the percentage of deviation relative to the cycle. The methodology is described in detail in

the ISO-23795 standard. The fleets are collecting data about carbon emissions as well as information about stop-and-go, acceleration and energy demand of the vehicle. Based on the speed profiles per vehicle, a classification of the trip, congestion and driving behaviour is reported as well as the quantity of additional carbon emissions relative to the standard. Together with the traffic volume known and published by the City of Hamburg, this allows to quantify the emissions of carbon dioxide in each area and road network.

- **H.2: 5G enabled GLOSA (Green Light Optimal Speed Advise).** The technology gives drivers some advice for best speed choices when crossing intersections using timeframes of "green, yellow and red". Additionally, GLOSA allows the vehicle to choose speed ranges which helps to avoid stops caused by intersections, a challenge for any automated vehicle moving in an urban and complex road network.
- **H.3: 5G enabled Collision Warning**. This technology is applied for collision alerts for vulnerable road users approaching the intersection as well as for collision alerts for vehicles platooning. In combination with GLOSA, a direct message is sent to the 5G smartphone App via Mobile Edge computing ensuring ultra-reliable low latencies possible only in the 5G network. The technology is urgently needed in all kinds of urban environments where autonomous vehicles are connected to a given road infrastructure existing from variable message signs, traffic lights or other traffic management functions and features (cellular V2X).
- **H.4: 5G enabled Carbon Emission Trading**. The database allows to exactly determine the amount of carbon emissions caused by the logistics fleets working on the supply chain in the maritime and aviation sector. By measuring the trip-based amount and by knowing the influence of certain traffic management activities (e.g., gate control, access control or park guidance management), the infrastructure operator can improve the overall emission situation and to clearly identify the carbon emissions caused by certain traffic and traffic management activities.

Table 3 resumes the activities carried on during 5G-LOGINNOV in relation to the KERs, and the future strategies that will be adopted by the stakeholders within the Hamburg LL.

Ker ID	Ker name	Exploitation report	Future plans
H.1	5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems	Based on the ISO-23795-1 standard, three different telematics platforms have been analysed while driving in a vehicle platoon. Impact assessment brought an average CO2 saving of 17%.	Sharing the experience of time to green and GLOSA with other European cities via ERTICO ITS Europe network to support the CO2 saving policy objectives in road transport.
H.2	5G enabled GLOSA (Green Light Optimal Speed Advise)	Green Light Optimum Speed Advise helped to stabilize the platoon behaviour in complex urban environments of Hamburg City centre. The app was used with the ISO-conform LCMM solution to find the difference of GLOSA and non-GLOSA information available in the platoon.	Move from mobile edge and time-to-green architecture to a fully integrated vehicle system and GLOSA information setup together with automotive partners.
H.3	5G enabled Collision Warning	The collision warning on intersection level jointly implemented by Continental and T-Systems for the ITS World Congress 2021 in Hamburg.	Move from mobile edge and time-to-green architecture to a fully integrated vehicle system and 5G enabled collisions warning together with automotive partners.

H.4	5G enabled Carbon Emission Trading	Based on the measured improvements of 17% CO2 reduction, the potential in carbon savings for smart city traffic management was examined and found to be of value for the upcoming emission trading system (ETS-2) of the European Commission.	Align the results in carbon savings with the political roadmap for introducing ETS-2 across Europe and link it to the environmental agencies.

Table 3: KERs of the Hamburg LL

2.2.2 Business recommendations for the future uptake of solutions

The Hamburg Living Lab has experienced an innovative paradigm shift by harnessing the potential of 5G networks and complementary technologies to revolutionize port operations. The future strategic focus extends beyond the confines of the port, emphasizing the seamless integration of activities within the port and its surrounding areas. At the heart of this transformation lies the pivotal role of 5G technologies, which serves as the baseline infrastructure, facilitating lightning-fast, high-volume data exchanges with minimal latency.

The future is based on key success factors:

- **Unveiling the (added) Value Proposition**. The (added) Value Proposition obtained thanks to 5G-LOGINNOV in the Hamburg Living Lab relies in the direct collection of data from vehicles to develop a real time monitoring of their status. This will disclose opportunities to implement AI and ML algorithms to optimise the vehicles' usage, with direct impacts on operations and on the reduction of negative externalities such as traffic congestion, emissions, and potential incidents and injuries for the port's personnel. A further positive impact of the Hamburg Living Lab is on the optimisation of the management of the flow of trucks and on the potentials to interconnect the vehicles, allowing truck platooning and minimising the costs related to waiting times.
- **Revolutionizing Supply Chain Monitoring.** Concerning the monitoring of the status of the supply chain, 5G networks and companion technologies will introduce unprecedented visibility by providing real-time data on the location and status of goods, leading to better planning and coordination throughout the logistics spectrum.
- **Fostering Innovation in Autonomous and Connected Vehicles**. The real-time collection of data from the vehicles will potentially enable the development and test of innovative products and services in the field of autonomous and connected vehicles, thus improving the remote piloting and control potentials, and reducing the need for on-site personnel in dangerous areas.
- **Strengthening the crucial Assets: 5G Infrastructure and Data Ecosystem**. The most important resource of the LL is the 5G infrastructure, as well as the platforms for data collection, analysis, and communication. Since all solutions developed and tested in Hamburg rely with collection and sharing of data, a central role is given by the analysis of the legal requirements (data confidentiality and GDPR) to ensure the compliance with national and European policies. Given the high importance of these activities, it is necessary to involve network operators and IT providers in the development phase, to ensure the feasibility of the solutions and the integration of the innovative systems with existing port processes. Moreover, considering the importance of the data exchange between vehicles and infrastructures, it is very important to involve vehicles' suppliers and infrastructure managers to ensure the correct data collection, integration, and exchange.
- **Setting-up a Sustainable Revenue Model**. The main costs are expected to be related to the development and the maintenance of the innovative products and services that mainly rely with ICT infrastructures, data analysis platforms, sensors for data collection, and human resources for the management and commercial activities. Instead, the future sources of will come from the usage and licensing fees from the interested users and stakeholders. It is moreover important to highlight that a primary source of revenue to consider may come from the optimisation of the operations and

management for both port's operators and external ones, with direct impacts on reduction of fuel consumption and emissions, time reduction for the logistics processes, and increase of the vehicles' efficiency (and of their lifetime).

2.2.3 Impacted stakeholders' categories and potential benefits

The following table resumes the main stakeholder types that may benefit from the Hamburg Living Lab results.

Stakeholders' groups	Potential benefits
Port authority	• Optimisation of the infrastructures' usage • Optimisation of the activities and processes in the port area • Increased capacity management • Compliance with net-zero carbon policies
Port Operations Manager	• Increased operational efficiency • Optimization of the management process of daily peaks • Deployment of truck platooning • Cost reduction • Time savings
Port/yard personnel	• Optimisation of the workflow and improved working conditions (reduction of work-related stress) • Reduction of risks and potential injuries • Increased alignment with internal and external operators and shippers
Public authority - Municipality	• Improved quality of life and working conditions in the urban area • Improvement of the safety in the road network • Sustainable traffic management (reduction of congestion and emissions) • Compliance with national and European sustainability goals
Logistics operators	• Improved planning of the activities (synchronisation of the terminal operations)

Table 4: Stakeholders and potential benefits: Hamburg LL

2.2.4 Barriers and mitigation actions

There are some potential barriers to consider for the exploitation of these solutions, as well as potential actions to overcome them:

- **Non-Standardized Level of Service Models for Data Collection**. Data collected from vehicles needs level of service models which are not standardized, making it challenging to establish a consistent and universally accepted framework for data analysis and optimization. An action to overcome this issue is the promotion of the ISO 23795-1 standard. This can help create a common language and framework for data analysis, making it easier for stakeholders to work together and leverage the collected data effectively.
- **Lack of Standardization in Hybrid Communication**. Hybrid communication is not yet fully standardized; leading to unclear deployment preferences in Europe and this can result in fragmented approaches to communication technology. To mitigate this barrier the promotion of a dialogue between stakeholders regarding the choice between ETSI G5 and cellular 5G for market-relevant deployment strategies shall be continued. Encouraging standardization bodies and industry players to work together to establish clear standards and guidelines can help create a more cohesive and unified approach to hybrid communication in the context of traffic management.
- **Difficult competitive landscape with other traffic management solutions**. Market competitive products in the field of traffic management include various portfolio offerings, making it difficult for new solutions to stand out and gain traction. This challenge can be addressed developing effective go-to-market research that identifies gaps and opportunities within the competitive landscape and

highlights the unique value propositions of the solutions offered by the start-ups. Furthermore, updating current roadmaps and deployment strategies so that they align with market demands and customer needs can help differentiating the solutions and place them more effectively in the market.

2.2.5 Exploitation strategies for new actors involved in the Hamburg Living Lab

The new actors involved in the Hamburg Living Lab are those that were awarded through the 5G-LOGINNOV Open Call for Start-ups :

- eShuttle, offering the 5G-Loginnov-4-Amazon (5G4A) solution.
- uze! Mobility GmbH, offering the TAXi-AD Data (TAADD) solution.
- Roads.AI, offering the Intelligent Traffic Guidance System (ITGS) solution.

The three companies have experience in the field of real-time data collection and management from vehicles, as well as of the analysis of data to provide valuable information to optimise the traffic flows in determined areas. Beside the specific applications in the Living Lab, the collection of reliable and real-time traffic data from vehicles and infrastructures is an important activity to measure the traffic conditions in a determined area.

2.2.5.1 Exploitation opportunities for 5G-Loginnov-4-Amazon (5G4A)

The reduction of negative externalities (congestion and emissions) related to traffic and logistics activities is primarily important at local and European level, and several efforts have been put in place in recent years to reach the sustainability goals defined by the European Union. Beside the importance of environmental sustainability, for the logistics sector the reduction of emissions and congestion often means an optimisation of the resource usage, with direct consequences on the reduction of fuel costs and time savings. Moreover, optimising the logistics processes means to increase the effectiveness of the entire logistics chain, thus making possible optimisation of warehouses and logistics hubs.

The 5G4A solution envisages three telematics devices targeted to improve dispatching and order management of Amazon fleets in the North of Germany showing the potential of carbon reduction by optimizing route and tour planning. For e-Shuttle, the business cooperation with Amazon is very successful and fruitful in terms of optimisation of the delivery tours, with reduction of carbon emissions. For the same reasons, the engagement with the project partners of 5G-LOGINNOV in Hamburg is useful to test the application of the 5G4A solution in the port sector. Specifically, the collaboration with 5G-LOGINNOV partners in Hamburg (T-System and tec4u) discloses the access to Floating Truck Emission Data (FTED) for tour analysis and eco-drive.

After the development and test of the positive impact of the 5G4A solution in the Living Lab context, the solution can be scaled and applied to different contexts, both for private traffic and for freight transport.

The partners of the 5G-LOGINNOV consortium can increase the development and test phase of the solution, creating a useful use case of the application of 5G4A in the port environment, also addressing issues related to policies and requirements in the logistics activities. Beyond the end of the project, the same consortium can act as an exploitation channel to foster the market adoption of the 5G4A tool.

Also in this case, the solution developed and tested in the Hamburg Living Lab is a potential accelerator for the commercialisation and market penetration, in terms of presentation of a use case for the future exploitation activity, as well as useful outcomes to overcome potential barriers to adoption (e.g., GDPR and data protection policies and regulations). Moreover, it is possible to increase the awareness of the solution among the potential customer targets through collaboration with public authorities and infrastructure managers, to exploit the potentials of traffic optimisation in terms of social benefits.

2.2.5.2 Exploitation opportunities for TAXi-AD Data (TAADD)

uze! Mobility GmbH offers an effective methodology to collect traffic data to be used for traffic optimisation, with direct positive effects on congestion and pollution, and with reduction of travel time and fuel consumption. The TAADD solution can collect the masses of required data to map out traffic participants, parking structures, environmental circumstances such as air pollution, street quality, space efficiency and many more in real time and over unlimited time periods. Data is collected by gearing up taxi vehicles (including self- driving vehicles, bicycles, motorcycles, and trucks) with digital displays that comprise sensors. The sensors continuously record situational geo-targeting criteria (e.g. weather, traffic situation, location, time). Additionally, repurposed data is acquired from a broad range of existing and accessible data bases such as governmentally provided services and data bases of IT companies and the automotive industry. Once the algorithms are trained, the TAADD solution will allow the collection of highly precise data to be used for different objectives.

Concerning the application of the TAADD solution in the Hamburg Living Lab, the main benefits for the project partners rely in the opportunity to access a large amount of data collected in the urban and suburban area, thus increasing the effectiveness of the use cases tested in the Living Lab.

Beyond the end of the project, the objective is to create a traffic data marketplace to be used for different purposes by different stakeholders, both public and private.

In this perspective, the partners of the 5G-LOGINNOV consortium can help the exploitation of the solution by allowing the LL spaces as a test field. Moreover, the analysis of the policies and regulations impacting the logistics and port environment, and the definition of the actions to comply with them, will foster the exploitation of the solution in other contexts. The organisation of workshops and live demonstrations of the TAADD solution can foster the increase of awareness between potentially interested stakeholders and final users, such as infrastructure managers and public authorities, positively impacted by the opportunity to increase the monitoring of public infrastructures. Moreover, the large amount of data collected by the vehicles is a very important source of information for applications related to autonomous driving, in terms of training of the AI algorithms for the control of the vehicles.

2.2.5.3 Exploitation opportunities for Intelligent Traffic Guidance System (ITGS)

The aim of ITGS is to improve traffic flows by transmitting optimal driving advisory to selected vehicles on the network, collecting data from different sources and analysing them to provide insights. In this context, the engagement of Roads.AI in the Hamburg Living Lab provides a very important chance to test the solution in a real-life industrial and logistics environment. On the other side, the 5G-LOGINNOV consortium has taken benefit from the expertise of Roads.AI in data collection and analysis to increase the effectiveness of the solutions tested in the specific use cases.

After the end of the project, the objective is to create a Traffic Management as a Service (TMaaS) to be used by logistics operators and fleet managers to optimise the processes, thus reducing congestion and emissions in the port and urban area and increasing the effectiveness of the operations.

The activities performed in the Hamburg Living Lab are therefore very important, allowing the development and test of the solution in the port and logistics context, also creating a valuable success story to foster for future exploitation activities. In these terms, the 5G-LOGINNOV consortium is an important channel for the exploitation of the ITGS solution, allowing its adoption in similar contexts. Moreover, ITGS solution can be exploited in contexts related with traffic and infrastructure management, due to its potential to increase the real time monitoring and control of traffic conditions and infrastructure usage, thus allowing a more effective infrastructure management. Other potential customer targets for the solution are fleet management companies and logistics service operators, positively impacted by the opportunities to optimise the vehicles' usage, with direct benefits related with increase of efficiency and reduction of operative costs.

2.2.5.4 Key Recommendations for the exploitation of new actors' solutions

Therefore, some key recommendations are provided, to push the exploitation of these companies' products:

- **Identify and Target Potential Customers**. The innovative solutions provided within 5G-LOGINNOV capabilities can be easily exploited beyond the project domains, allowing the implementation of environmental sustainability actions by Municipalities and Public Authorities. In fact, Public Authorities and Infrastructure Managers can represent potential target customers, having the objective to optimise the traffic flows in the urban area, thus reducing negative externalities, improving the quality of life for citizens, and meeting local, national, and European sustainable goals. Moreover, ITS Providers are an interesting potential target of these innovative solutions, as they need to improve the effectiveness and the responsiveness of the services provided to their final users.
- **Explore Autonomous Driving Opportunities**. Another interesting direction, and a relatively new business opportunity, for the exploitation of the solutions introduced by the three start-ups relies in the provision of the collected data for the development and test of autonomous driving systems, both for the logistics sector (e.g., truck platooning) and private transport. In this context, the ability of the 5G networks to provide a resilient, high-speed and high-volume information exchange between vehicles and infrastructures plays a central role.
- **Ensure Economic Sustainability through Data Provision.** Given the potential customer targets, the economic sustainability of the innovative solutions developed in Hamburg is based on the provision of collected data, with different potential pricing strategies such as usage and licensing fees. Moreover, the establishment of partnerships with Municipalities and Public Authorities can have positive impacts in terms of improving development of the data collection infrastructures, thus speeding up the growth of the service.

2.3 Exploitation Report of the Koper Living Lab

2.3.1 Summary of Key Exploitable Results (KERs) of the Koper Living lab

In the Koper Living Lab, two KERs have been defined. They are aimed at introducing and implementing 5G mobile systems and IoT devices to increase the capacity of collecting, analysing, and sharing data among the different parts of the logistic chain, improving ports' operations.

The KERs defined within Koper Living Lab are:

- **K.1: Improved private 5G mobile system for use cases in port and logistics domain**. While general solutions usually miss certain specific requirements needed to correctly address business processes, this solution will incorporate specific network and services customizations and adaptations to meet business KPIs required by ports/logistics domain which will be studied and examined throughout the 5G-LOGINNOV project in cooperation with technology and business experts.
- **K.2: Improved Industrial IoT System for specific needs of the ports and logistics domain**. This technology will ensure secure, resilient and QoS guaranteed 5G connectivity for non-5G IoT devices, e.g., various sensors, cameras, etc., and will be improved by several technical innovations. Based on an upgraded hardware platform, 5G NSA and SA mode of operation will be supported and a cloud-native approach will be introduced for the Industrial IoT System's software components. This will allow for automated deployment (either on far-edge, edge or core IaaS, depending on specific requirements), on boarding, scaling, self-healing, etc. The cloud-native approach will also result in IaaS's readiness for the orchestration within the 5G ecosystem.

Table 5 resumes the activities carried out during the 5G-LOGINNOV project for the exploitation of each KER and the strategies that will be adopted by the stakeholders for ensuring the further uptake.

Ker ID	Ker Name	Exploitation report	Future plans
K.1	Improved private 5G mobile system for use cases in port and logistics domain	The KER has been disseminated in multiple conferences and events. Besides, the KER has been also utilized for consultation purposes on frequency spectrum usage and, as well, for specifying requirements for development equipment purchase	Plans mainly include exploitation and further development of the KER in upcoming research activities, such as NEPHELE and 6Green projects, as well as its further dissemination.
K.2	Improved Industrial IoT System for specific needs of the ports and logistics domain	The KER has been disseminated in multiple conferences and events. The knowledge represented by this KER, has been also used in the process of designing other Industry 4.0 and PPDR related applications developed and demonstrated in other Horizon projects.	Plans mainly include exploitation and further development of the KER in upcoming research activities, such as NEPHELE and 6Green projects), as well as its further dissemination.

Table 5: KERs of the Koper LL

2.3.2 Business recommendations for the future uptake of solutions

The Koper Living Lab has consistently supported the development and testing of 5G-enabled technologies, tailored towards advancing the automation of logistics processes within ports and strengthening mission-critical services in the port area.

The business strategy for future exploitation relies on the following enabling conditions:

- **Deploying cutting-edge video surveillance systems as core of the value proposition.** These systems leverage high-definition cameras integrated into port machinery to meticulously capture information concerning container markers and detect container damages. The value proposition of these innovations is two-fold. Firstly, they directly contribute to the optimization of port operations, leading to reduced downtimes and enhanced container handling efficiency. Secondly, they elevate security conditions by providing an improved detection system for damages, safeguarding valuable cargo.
- **Enhancing Safety and Security through 5G**. The central role of the 5G networks relies in its potential to ensure the data collection and exchange through a reliable, resilient, and low latency infrastructure. This allows real-time detection of potential sources of risk or non-compliance situations for the containers.
- **Leveraging Virtual Network Functions (VNF)**. The 5G architecture can be used for the deployment of Virtual Network Functions (VNF) to enable automatic and on demand components, with the aim to improve the communication in the port environment, optimising operations and processes. Further positive impacts in terms of optimisation of port processes, and integration of information flows, come from the data collection and sharing with other port support systems.
- **Enhancing integration of information flows and new strategic partnerships**. The systematic collection and sharing of data with other port support systems (such as the Terminal Operation System-TOS) fosters greater integration of information flows, bolstering overall efficiency. For these reasons, it is important to establish partnerships with network and telecom operators and IT providers, as well as with the providers of technological assets (high-definition cameras and surveillance systems) and port machineries.
- **Balancing Costs and Revenues.** The primary expenses pertain to the development of the 5G architecture, acquisition of video surveillance systems, and their seamless integration into the existing

port ecosystem. Post-development, administrative, commercial resources and legal competencies are essential to guarantee compliance. Concerning the economic sustainability of the solutions, the main sources of revenues beyond the end of 5G-LOGINNOOV project can be licensing and usage fees paid by external operators. Moreover, it is important to remark that a relevant benefit comes from the increased safety and security allowed by the video surveillance system, with direct impact on the optimisation of the port's processes.

2.3.3 Impacted stakeholders' categories and potential benefits

The following table lists the main stakeholder types that may benefit from the Hamburg Living Lab results.

Stakeholders' groups	Potential benefits
Port authority and Operations Managers	• Improved services based on 5G communication to optimise activities and processes • Improved effectiveness of operation planning and reduction of downtimes
Security managers	• Increase of the monitoring of the port areas (detection of potential sources of incidents and injuries, identification of human presence in not allowed areas) • Improvement of the working conditions of port personnel
ICT managers	• Increased quality of collected data
Fleet managers	• More effective usage of port machineries (increase of lifetime, reduction of damages)
Port personnel	• Improvement of safety and security conditions, increase of working conditions, and reduction of potential sources of injuries and working stress

Table 6: Stakeholders and potential benefits: Koper LL

2.3.4 Barriers and mitigation actions

Beside of the exploitation plans, it is important to identify the potential barriers to the wide adoption of the results of the Koper Living Lab.

- **End-users' reluctance to accept new solutions**. The new technology and its benefits may not be immediately embraced or understood by potential users, leading to resistance or reluctance. To address the end-user acceptance barrier, the local partnership should actively engage with potential users. Presenting the system's functionalities and highlighting its advantages in real-world scenarios can help build trust and understanding among end-users. New demonstrations, pilot projects, and user-friendly interfaces can also ease the transition.
- **Absence of a regulatory framework for autonomous drone operations**. Without clear regulations and guidelines, it's challenging to conduct operations safely and legally. The methods used to validate the system functionalities can be presented to EASA and local Civil Aviation Authorities in order to contribute to the development of the necessary regulatory framework for autonomous drone operations, which have not been set by any regulatory body.
- **Low public trust**. Concerns about privacy, safety, and unfamiliarity with autonomous drone technology may hinder public support and trust. Extensive public awareness campaigns should focus on educating the general public about autonomous drones' operations, applications, and their advantages. Highlighting benefits such as reduced environmental impact, enhanced safety, and cost-effectiveness compared to traditional transportation methods can help garner support and alleviate concerns.

2.3.5 Exploitation strategies for new actors involved in the Koper Living Lab

The new actor involved in the Koper Living Lab is Hellenic Drones, providing the TRITON Solution. They provide an innovative solution based on autonomous drones to enable the control and monitoring activities in the port area, thus improving safety and security by early detection of potential sources of danger. Data from multiple cameras (drone forward cameras, drone 360 cameras, ground cameras) will feed the MOT (Multiple Object Tracking) modules to enable precise estimation of the moving objects' trajectories.

2.3.5.1 Exploitation opportunities for TRITON

TRITON offers a cost-effective alternative to the traditional methods for port-to-ship deliveries, security monitoring, and inspections of critical port infrastructure, and consequently TRITON B2B addressable market may consist of port authorities, and port service providers. Globally there are 1817 registered well-known ports and in each one of them many different service providers carry out services that can be conducted more efficiently by drones that will be integrated with TRITON.

Now, the methods used to conduct critical port operations (e.g., port-to-ship deliveries, inspections of critical port infrastructure, environmental surveys, and port security monitoring) can be unsafe for humans, time consuming, expensive, environmentally harmful, and not particularly effective. For these reasons, port authorities, shipping companies and regulatory authorities are investigating alternative solutions. The recent developments in drone technology can provide promising solutions to the challenges. Namely, drones have been developed that can carry a payload up to 200kg and their range can reach 250km. These unmanned vehicles can be used to transport people or material between ports and ships faster, cheaper, and since they are electrically powered, they do not produce greenhouse gases. Furthermore, a wide variety of sensors can be mounted on smaller drones to conduct environmental surveys, inspections, and security monitoring. However, by considering the number of drone operations that can be conducted simultaneously in a port environment, to create a sustainable and scalable concept of operations, drones should be able to navigate autonomously considering other aerial vehicles operating in the port's airspace such us moving obstacles (birds, moving cranes) and the drones' energy reserves.

To address the above-mentioned challenges, the company has created a proactive plan of action. More specifically, the TRITON project will leverage the consortium of the 5G-LOGINNOV project to present the system's functionalities and present its advantages to end-users (5G-LOGINNOV Living Labs). Moreover, the methods used to validate the system functionalities will be presented to EASA and local Civil Aviation Authorities to contribute to the development of the necessary regulatory framework for autonomous drone operations, which have not been set by any regulatory body.

Findings of the TRITON application will contribute significantly to a rigorous discussion regarding autonomous drone operations and will ultimately accelerate the development of the relevant regulations that will pioneer air transport services. Finally, TRITON accounts for the dissemination of the system's outcomes to the public to increase the awareness outside the aerospace industry with autonomous drones' operations. Also, the applications that autonomous drones can have in urban and rural environments and their advantages (reduced environmental footprint, increased safety, and reduced costs) compared to the traditional methods of transportation will be highlighted.

2.3.5.2 Key Recommendations for the exploitation of new actors' solutions

The key recommendations for the exploitation of TRITON are the following.

- **Diversify Application Contexts and explore Innovative Autonomous Systems**. Expand the application of the TRITON Solution beyond the Living Lab and the project duration. Explore opportunities in both private and public sectors to enhance monitoring capabilities and contribute to improved safety and security conditions. Continue to invest in the development and testing of

innovative autonomous drone-based systems. These systems have the potential to open doors to new applications, such as handling operations in the logistics sector, particularly in port areas. Stay at the forefront of drone technology to remain competitive.

- **Recognize the vast array of potential customer targets for the TRITON Solution.** This includes security control companies, warehouse and logistics operators, and public authorities interested in monitoring specific areas. It is relevant to tailor marketing efforts and solution offerings to address the unique requirements and challenges of each customer segment.
- **Emphasize a business model based on usage and licensing fees**. Given the specialized expertise and assets required for autonomous drones, the most promising way to sell the service and ensure its economic sustainability is through the payment of usage and licensing. The implementation of autonomous drones requires specific expertise and specific assets. This implies that fees may be structured based on the number of drones deployed, allowing for flexibility and accommodate diverse customer needs.

3 TRANSFERABILITY ANALYSIS FOR THE SOLUTIONS VALIDATED AT THE THREE LIVING LABS

To assess the potential transferability of the main Key Exploitable Results validated in the 5G-LOGINNOV Living Labs in other contexts, a survey has been developed and promoted to a target of European Union logistics stakeholders. This Section provides an overview of the survey results; specifically, Section 2.1 defines the overall framework, while Section 2.2 reveals the main results of the assessment. The survey text is available in Annex 1.

3.1 Transferability assessment framework

The survey has been active from February 2023 up to September 2023 and has been promoted amongst the audience of logistics and telecom stakeholders, both big and small players, from the public and private sector.

The aim was to reach respondents with a good knowledge on the topics, and with good motivation and interest for the 5G-LOGINNOV findings. The main strategy to reach respondents has been establishing a direct contact and a direct request to specific individuals, through business connections of the 5G-LOGINNOV partners or members of the ALICE Network. Also, for the sake of promotion of the project, the request to fill the survey occurred also within the CIRCLE and ERTICO's newsletters and through the 5GPPP mailing list. In total 34 people have responded to the survey.

The respondents of the survey represent a wide audience of stakeholders; mainly innovators, port authorities, research centres and telco operators (Figure 1 provides the distribution). They come from different geographical areas and with diverse dimensions:
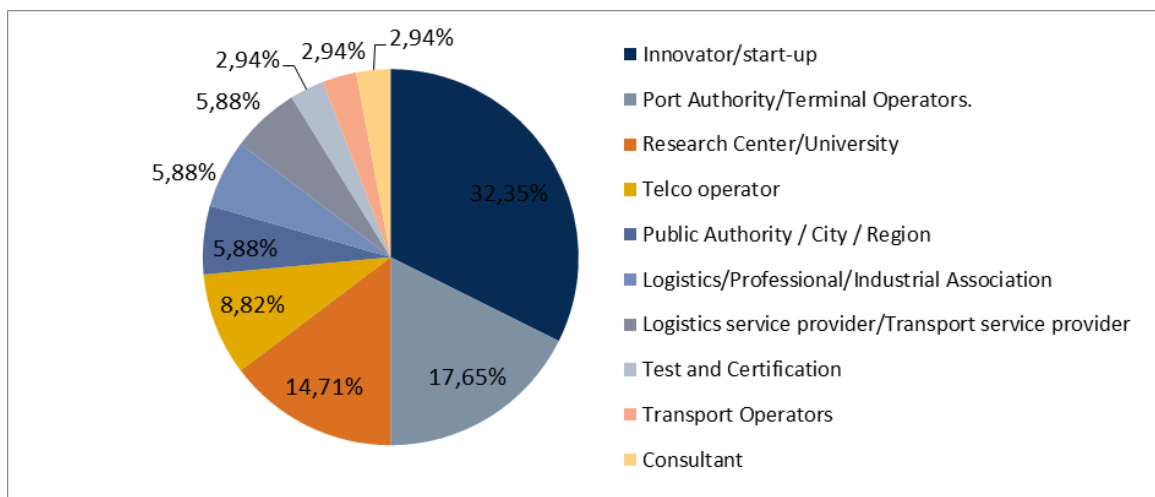
Figure 1: Survey respondents: stakeholders' type
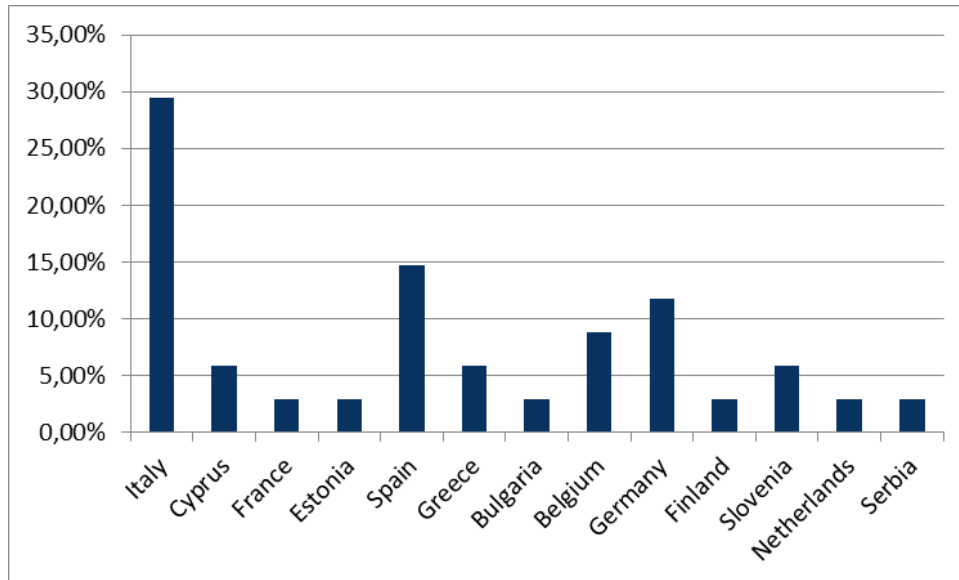
Figure 2: Survey respondents: Countries
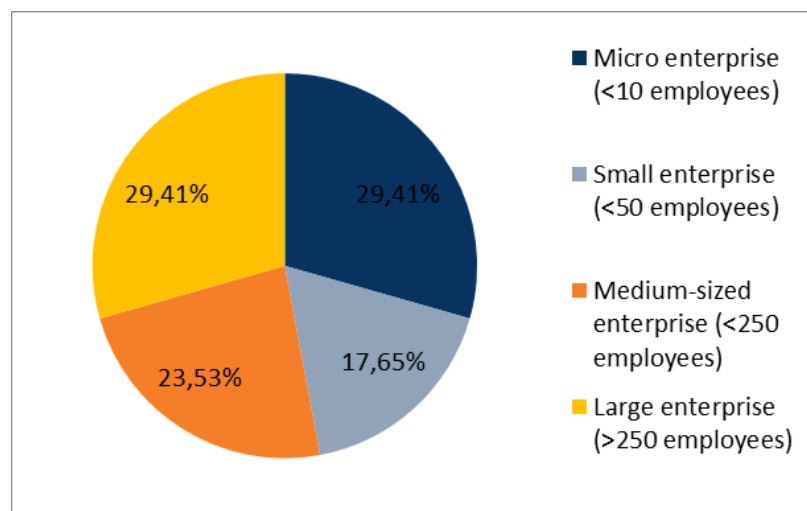
Figure 3: Survey respondents: company size

3.2 Results of the transferability assessment

5G-LOGINNOV provided the three Living Lab (Athens, Hamburg, Koper) with the possibility to develop and implement innovative logistics applications thanks to the usage of the 5G-enabled network. As described in Section 2, ten technological KERs have been developed during the project in the context of the three Living Labs:

- A.1: 5G and IoT Platform in Port Operations (Athens)
- A.2: 5G&AI-enabled container seal detection for supporting logistics process (Athens)
- A.3: 5G&AI-enabled human presence detection to support safety/security operation. (Athens)
- A.4: 5G Truck Fleet Management Platform (Athens)
- H.1: 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems
- H.2: 5G enabled GLOSA (Green Light Optimal Speed Advise).
- H.3: 5G enabled Collision Warning.
- H.4: 5G enabled Carbon Emission Trading.
- K.1: Improved private 5G mobile system for use cases in port and logistics domain.

- K.2: Improved Industrial IoT System for specific needs of the ports and logistics domain

The survey allowed respondents to choose more than one KER as potentially transferable in other contexts.

It resulted that the most interesting technologies are the

- K.1: Improved private 5G mobile system for use cases in port and logistics domain (Koper)
- K.2: Improved Industrial IoT System" (Koper)
- A.1: 5G and IoT Platform in Port Operations (Athens)
- H.1: 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems (Hamburg)
- H.2: 5G enabled GLOSA (Hamburg).

The survey revealed that the main scopes motivating external stakeholders to adopt these technologies are:

- enhancing safety and security measures
- improving operational efficiency,
- achieving cost reduction,
- promoting environmental sustainability
- facilitating digital innovation and collaboration throughout the port ecosystem.

The main risks and blockers for scaling up these technologies include:

- the significant infrastructure investments required for 5G implementation,
- potential customer reluctance to embrace new technologies,
- intricate implementation processes,
- regulatory variations in different regions.

Additionally, some technologies face challenges in recognizing their value proposition, and there are concerns about the suitability of certain technologies for the complex port environment.

The main critical success factors perceived as enablers for scaling up these technologies are:

- the establishment of cooperation or federations among logistics operators to create a genuine digital port ecosystem.
- the fostering of digital innovation throughout the port
- the engagement in lobbying activities with governmental institutions
- the Availability of real-time and large-scale data processing capabilities

Figure 4 reveals the distribution of the preferences and the next section provides a detailed overview of the transferability assessment for each result
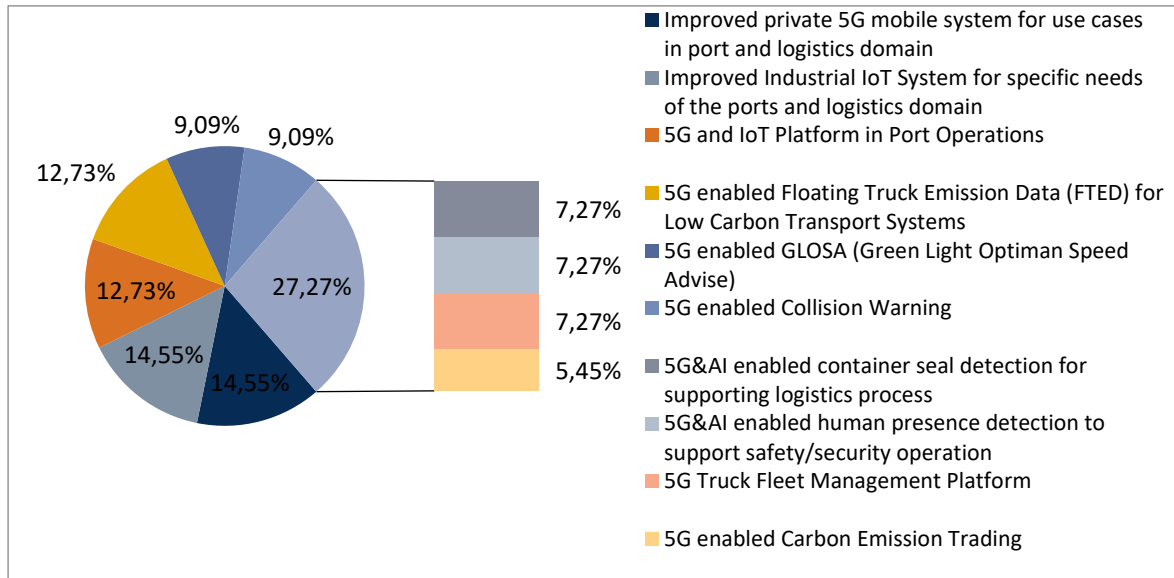
Figure 4: Transferability assessment summary

A.1: 5G and IoT Platform in Port Operations

It is evident that the «5G and IoT Platform in Port Operations» holds great potential for reuse, particularly in enhancing safety and operational efficiency. Moreover, it is worth noting that considerations of security, cost reduction, and the seamless integration of data-driven, digitally automated processes are of paramount importance.

This technology is anticipated to meet the demands for heightened security measures, safety protocols, comprehensive traffic status information, and cost-effectiveness. However, there are significant perceived challenges and obstacles to the widespread adoption of this technology. These include the intricate nature of its implementation, requiring a noteworthy financial commitment and a collaborative go-to-market strategy. Additionally, substantial infrastructure investments are imperative for the deployment of 5G, and it is notable that some potential customers may not fully recognize the value proposition of this technology.

Conversely, there are pivotal success factors that can act as catalysts for the adoption of this technology. One such factor is the potential to establish cooperative arrangements or federations among logistics operators, with the ultimate aim of cultivating a genuine digital port ecosystem. Furthermore, this technology can pave the way for digital innovation and collaboration across various stakeholders within the port, ultimately leading to progress and heightened efficiency.

A.2: 5G&AI-enabled container seal detection for supporting logistics process

The «5G&AI-enabled container seal detection for supporting logistics process » will find application in diverse contexts primarily to enhance the efficiency of port operations, reduce associated costs, and bolster economic prosperity.

This technology holds promise for reuse to meet needs related to heightened security, improved human detection within the port area, and overall cost reduction. However, several perceived obstacles exist concerning its broader adoption. Foremost among them are the substantial infrastructure investments required for 5G implementation. Additionally, concerns persist that the technology may not be sufficiently tailored to the complex demands of port environments, and there may be challenges in updating or upgrading software and services to accommodate this technology.

To facilitate and promote the scalable deployment of the "5G&AI-enabled (far-) edge video analytics service for container seal detection with NFV-MANO support," several critical success factors come into

play. These include the establishment of cooperative arrangements or federations among logistics operators, with the objective of fostering a genuine digital port ecosystem. The creation of a reliable regulatory and organizational framework for data sharing, while safeguarding individual business interests, is also crucial. Furthermore, proactive communication strategies by port authorities with the hinterland, real-time and large-scale data processing capabilities, and the synchronization of sea-land operations are all perceived as facilitating factors in this endeavour.

A.3: 5G&AI-enabled human presence detection to support safety/security operation

The "5G&AI-enabled human presence detection to support safety/security operation" will be able to address safety and security requirements, aligning with the key needs identified by stakeholders willing to adopt this solution.

The principal impediment foreseen in introducing this tool lies in the substantial infrastructure investments required for the implementation of 5G technology. On the flip side, the primary enabler for its broader adoption is the enhanced potential for collaborative projects in research and development, addressing environmental concerns, and enhancing safety and security, as well as inland infrastructure development. Additionally, the establishment of a reliable regulatory and organizational framework for data sharing while safeguarding business interests, coupled with the increased feasibility of real-time and large-scale data processing, will significantly facilitate the expansion of this tool into different contexts.

A.4: 5G Truck Fleet Management Platform

The "5G Truck Fleet Management Platform" is poised to find adoption primarily aimed at optimizing logistics operations' efficiency and advancing data-driven and digitally automated processes.

This tool holds substantial potential for meeting the imperative needs of enhancing environmental sustainability within operations and reducing associated costs. Nonetheless, there are several perceived obstacles to its widespread adoption. These include the inherent challenges associated with floating vehicle data, such as issues related to spatial and temporal coverage leading to potentially unreliable statistics. Additionally, the technology's intricate implementation demands a significant financial commitment and a coordinated go-to-market strategy. There's also the apprehension that potential customers may not yet be ready or willing to embrace new technologies. Moreover, the reliance on algorithms trained on private datasets poses vulnerability to adversarial attacks that could confound the inference engine. Lastly, concerns persist that the technology may not be sufficiently tailored to meet the complex requirements of the port environment.

Nevertheless, the most pivotal enabling factor that stakeholders envision for the successful adoption of the 5G Truck Fleet Management Platform technology is its capacity to enhance real-time and large-scale data processing capabilities.

H.1: 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems

The "FTED" technology holds interest beyond 5G-LOGINNOV primarily for the purpose of enhancing operational efficiency. Additionally, it is also seen as valuable for achieving a higher degree of centralization in data and information sources and for boosting economic prosperity. Furthermore, it plays a role in enabling more accurate quantification of emissions resulting from low-carbon transport operations, according to perspectives beyond 5G-LOGINNOV.

The central need for which this technology is deemed relevant centres on cost reduction. Nevertheless, it is anticipated to address a broader spectrum of needs, encompassing energy conservation, congestion reduction, and overall improvements in the environmental impact of operations.

The primary impediments to scaling up the adoption of this technology are multifaceted. Firstly, the reliance on floating vehicle data, often sourced from competitors such as fleet operators and public authorities presents a challenge, as these entities may prefer to retain their data. Secondly, the significant infrastructure investments required for 5G implementation pose a notable barrier. Furthermore, the readiness and willingness of potential customers to embrace new technologies remain uncertain, and there may be complexities associated with updating and upgrading software and services to effectively implement this technology.

Conversely, the key success factors identified for the scalability of FTED technology entail the establishment of a trustworthy regulatory and organizational framework that allows for data sharing while safeguarding individual businesses. Collaborative initiatives, particularly in research and development, green initiatives, safety and security, and inland infrastructure development, are pivotal for its advancement. Moreover, the capacity to process data in real-time and on a large scale is considered instrumental in facilitating its broader adoption.

H.2: 5G enabled GLOSA (Green Light Optimal Speed Advise)

The "5G-enabled GLOSA (Green Light Optimal Speed Advice)" technology is poised for adoption with the primary aim of reducing traffic congestion and incidents, while also enhancing safety in port areas.

The critical needs that this technology is expected to address encompass a wide spectrum. These include the imperative to elevate safety standards, acquire comprehensive traffic status information, conserve energy, alleviate congestion, and, on a broader scale, enhance the overall environmental sustainability of port operations.

The most significant perceived risk associated with further implementations revolves around the substantial infrastructure investment required for 5G deployment. Otherinvestment might potentially limit other locations from utilizing GLOSA technology effectively.

However, there are several promising factors that can facilitate the scaling up of GLOSA. These include fostering a culture of digital innovation and collaboration throughout the port ecosystem, undertaking joint marketing and communication initiatives, and engaging in lobbying activities with governmental institutions. Additionally, the ability to process data in real-time and on a large scale is identified as a key success factor in the expansion of GLOSA technology.

H.3: 5G enabled Collision Warning

The "5G-enabled Collision Warning" technology is poised for adoption primarily to reduce traffic congestion and prevent accidents. In scenarios where multiple tug masters are operational, alongside a significant presence of personnel in confined areas, the implementation of collision warning systems can play a crucial role in averting accidents and ensuring the safety of individuals.

By introducing this technology, the overarching need for enhanced safety is effectively addressed, alongside the need to advance autonomous vehicle capabilities within the port environment.

The primary anticipated impediment to widespread adoption lies in the readiness and willingness of potential customers to embrace new technologies.

Similarly to the 5G enabled GLOSA, the most impactful success factors for the adoption of this technology revolve around fostering a culture of digital innovation and collaboration throughout the port ecosystem. Additionally, engaging in lobbying activities with governmental institutions is identified as instrumental in facilitating its uptake and implementation.

H.4: 5G enabled Carbon Emission Trading

The "5G-enabled Carbon Emission Trading" technology is expected to be uptake primarily to foster enhanced business cooperation. Moreover, it holds significant potential for providing valuable insights

into the effects of vehicles (e.g.: trains) arrival, composition, and dispatch processes at terminals in local traffic, particularly when interfacing with trucks.

This technology is expected to effectively address the pressing needs related to bolstering environmental sustainability and reducing operational costs.

Nevertheless, there is a set of potential risks associated with its implementation, notably the substantial infrastructure investments required.

Conversely, it is widely acknowledged that the primary enabler for this technology lies in the establishment of cooperation and/or federation among logistics operators, with the ultimate aim of creating a genuine digital port ecosystem. This collaborative approach is seen as pivotal for the successful uptake and deployment of the technology.

K.1: Improved private 5G mobile system for use cases in port and logistics domain

The "Improved private 5G mobile system for use cases in port and logistics domain " has gathered significant interest from external stakeholders in the 5G-LOGINNOV project. These stakeholders are keen to adopt it primarily to enhance operational efficiency, facilitate precise communication, and offer recommendations for various operations, including improving communication between field operations and the office control tower. Additionally, the technology is seen to reduce operational costs and centralize data and information sources effectively.

This technology is expected to address critical needs related to security, cost reduction, and the advancement of autonomous vehicle development and implementation within the port and logistics domain.

The primary perceived barriers for adoption are the substantial investment required for the implementation of 5G infrastructure, regional-specific regulatory requirements, and the potential challenge of stakeholders not recognizing the value of this technology.

The establishment of cooperation or federations among logistics operators, with the aim of creating a genuine digital port ecosystem, is considered a pivotal success factor for further adoption of this technology. Moreover, encouraging digital innovation and collaboration throughout the port, ensuring market openness, and allowing the entry of competitive private investors are factors that will facilitate its uptake. It is widely recognized that innovation will not only impact an individual company but also its partner organizations.

K.2: Improved Industrial IoT System for specific needs of the ports and logistics domain

The "Improved Industrial IoT System for specific needs of the ports and logistics domain" is anticipated to address a wide range of objectives, including increased efficiency, more precise operational communication, cost reduction, and the mitigation of traffic congestion and incidents.

This technology is expected to effectively fulfil the needs associated with automating the container seal checking process, expediting vessel unloading operations, enhancing security and safety measures, and promoting greater environmental sustainability within port operations.

The primary anticipated risk in scaling up this technology pertains to the readiness and willingness of potential customers to embrace new technologies, compounded by the complexity of implementation, which necessitates a significant financial commitment and a coordinated go-to-market strategy.

The most critical success factor for the widespread adoption of the "Improved Industrial IoT System" is the establishment of cooperation or federations among logistics operators, with the overarching goal of

creating an authentic digital port ecosystem. Additionally, the development of new collaborative projects in research and development, green initiatives, safety and security, inland infrastructure development, and the promotion of digital innovation and collaboration throughout the port environment will significantly facilitate the uptake of this advanced IoT system.

4 EXPLOITATION STRATEGIES OF HORIZONTAL KERS

The 5G-LOGINNOV project has achieved important outcomes that go beyond specific technologies. These KERs are significant because they are expected to contribute to further knowledge, research, and innovative ideas. These results come from the project's activities that are not tied to specific Living Labs, making them "Horizontal" 5G-LOGINNOV KER. They include findings and outputs that have the potential to impact the broader field of 5G technology and its applications. Unlike KERs generated within specific Living Labs, which may be more specific to a particular context or application, Horizontal KERs have a broader reach. They can inform and inspire research and innovation across different areas. Labelling these results as "Horizontal" highlights their cross-cutting nature and their ability to connect different parts of the project. They encourage collaboration and the exchange of ideas across different fields. The five Horizontal KERs. Generated during the 5G-LOGINNOV Project is the following:

- P.1: Data handling procedures
- P.2: Evaluation methodology
- P.3: 5G-enabled Products & Services Register
- P.4: Network of 5G enabled start-ups and innovative players
- P.5: 5G-LOGINNOV Position Papers

For each of them, this chapter provides the description of the exploitation activities performed during the project duration, and the future exploitation plans.

P.1: Data handling procedures

The P.1: Data handling procedures established in the 5G-LOGINNOV project encompasses a comprehensive set of directives and principles, tailored to ensure the secure and effective management of project data. This approach addressed aspects such as data access, storage, sharing, and disposal, with a special focus on the treatment of personal data.

Throughout the duration of the project, a dynamic approach to data handling was maintained. This involved constant vigilance in monitoring the challenges that emerged within the LLs. Regular meetings have been organised to facilitate the adoption of data handling guidelines, the data management plan, and the requisite tools. This adaptability ensured that the project's data strategy remained aligned with the evolving requirements of the endeavour. It guaranteed that data was handled efficiently, securely, and in accordance with the project's objectives.

Beyond the immediate project scope, the future strategy will envision a seamless transition to providing consultancy and engineering services by AKKODIS (the leading partner for the management of the Data handling procedures) and the other project partners that contributed. These services will be extended to potential customers operating within the realm of port operations. By leveraging the expertise and insights gained through 5G-LOGINNOV, the aim is to offer valuable support to potential clients seeking to optimize their operations, enhance efficiency, and harness the power of 5G technologies in the port industry. This strategic extension underscores the long-term vision of applying the knowledge and best practices acquired during the project to benefit a wider audience in the domain of port logistics.

P.2: Evaluation methodology

The strength of the "P.2: Evaluation Methodology" is its versatile application in assessing the impacts of 5G-LOGINNOV Use Cases. Additionally, this methodology holds potential for broader deployment in the implementation of analogous services and applications across various ports and transportation platforms. The primary partners in this endeavour are ICOOR, ICCS and AKKODIS.

Within the 5G-LOGINNOV project timeline, the Evaluation Methodology was prominently showcased. It was presented at prestigious events such as the [IEEE Future Network World Forum in 2022](#) and ITS [EU Congress Toulouse 2022](#). These presentations aimed to disseminate knowledge about the methodology's effectiveness and relevance. By showcasing its success within the project, it not only contributed to the project's objectives but also positioned the methodology as a noteworthy innovation in the field of 5G-enabled logistics and transportation.

The exploitation strategy envisions the intention to leverage this methodology in the broader context of European projects related to ports and telecommunications. For instance, a common effort between the partners involved is foreseen in the context of new project proposals, mainly in Horizon Europe Cluster 5 (Destination 6).

P.3: 5G-enabled Products & Services Register

The "P.3: 5G-enabled Products & Services Register" developed within the 5G-LOGINNOV project is a comprehensive catalogue of 5G-enabled products and services. This register not only encompasses the solutions utilized within Living Labs areas but also extends its focus to evaluate their impact on port operations and business models. Furthermore, it offers a comparative analysis of alternative products available in the market, catering to similar objectives. The development of this register was managed by ICOOR, with active support from all partners participating in Living Labs activities.

Throughout the duration of the project, its findings and contents have been presented and published at events such as [IPIC 2023 in Athens](#) and the [ITS EU Congress 2023 in Lisbon](#). These presentations have served as platforms to showcase the register's key discoveries, further highlighting the project's objectives, and positioning itself as a valuable resource within the wider logistics communities.

The exploitation strategy for the future entails the continued use of the "P.3: 5G-enabled Products & Services Register" beyond the boundaries of the 5 G-LOGINNOV initiatives, and it is envisioned as a foundational tool for future market analyses. Moreover, by integrating this register into subsequent EU projects, it will continue to facilitate research, innovation, and decision-making processes within the domain of 5G-enabled products and services, thus fostering advancements in port operations and related industries.

P.4: Network of 5G enabled start-ups and innovative players

The "P.4: Network of 5G-enabled Start-ups and Innovative Players" is made of start-ups, winners of the [5G-LOGINNOV Open Call for Innovative Start-ups](#), that have played a pivotal role in accelerating the adoption of 5G innovative applications in the projects LLs' ports . Furthermore, the network has expanded its reach by engaging with additional start-ups through strategic initiatives initiated by 5G-LOGINNOV, mainly within Task 4.2.

Throughout the project, the entire consortium has actively supported the development and growth of this network. The project's activities and achievements in fostering the network's exploitation are comprehensively documented in Deliverable 4.3, particularly in Section 2. This report outlines the collaborative efforts undertaken with the winners of the 5G-LOGINNOV Open Call, as well as with other external actors. These collaborations have been instrumental in advancing the network's objectives and expanding its influence within the industry.

Looking ahead, the sustainability of the network is expected to be fuelled by joint participations in new EU-funded projects, creating a synergy of ideas and resources. This will further drive innovation in the domain. To push for this scope, specific training has been provided to these companies on opportunities within the Horizon Europe framework. The collaborative environment fostered by the 5G-LOGINNOV Project will continue to facilitate connections and partnerships among network members. Moreover, [the Dock of the Future Network of Excellence](#), spearheaded by CIRCLE, and the [ERTICO Start-ups Initiatives](#) will play a pivotal role in supporting the ongoing development of the 5G-LOGINNOV Network.

This collaboration ensures that the network's objectives remain aligned with the evolving needs of the industry, and it enhances the network's reach and influence among its participants.

P.5: 5G-LOGINNOV Position Papers

Two position papers have been developed. One Policy Paper addresses 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. The other focuses on recommendations to enhance research, development, and deployment of AI applications to support most optimal logistics supply chain and port operation.

The 5G-LOGINNOV Consortium supported the creation of these position papers, but their final development and distribution was led by ERTICO. To exploit the recommendations gathered in the two position papers, within the 5G-LOGINNOV project timeline, they were presented at prestigious events such as the ITS EU Congress in Lisbon 2023 and in a webinar organized together with the 5G-MOBIX and 5GMETA projects. These presentations aimed to disseminate knowledge about the recommendation's relevance and to instigate a call of action for the policy makers and relevant stakeholders involved. The exploitation strategy for the future includes further dissemination of the recommendations. Moreover, the lessons learnt gathered through the development of the policy recommendations, will be further exploited in future projects related to 5G that ERTICO and other partners pursue.

5 INDIVIDUAL STRATEGIES TO EXPLOIT 5G-LOGINNOV RESULTS BY CONSORTIUM MEMBERS

The project has been a success story for all the partners of the project Each Consortium member could benefit from the project by either reinforcing internal capabilities or by acquiring new services that will provide a competitive advantage in the future. In all cases, 5G-LOGINNOV was able to fully satisfy the partners expectations that have been defined in the first part of the project (details are available in section 5 of Deliverable 5.4 "Exploitation Plan") and led to new opportunities and future possibilities to exploit the project results.

This chapter reports the exploitation approaches adopted by each project partners and summarises the plans to scale up the most relevant results generated in 5G-LOGINNOV. Annex 2 allows to check the main changes compared to the list presented in Deliverable 5.4 "Exploitation Plan", Annex 3 provides the full list of individual results, including a brief description, the application area and the exploitation route defined for each result.

5.1 ERTICO

The ERTICO's partnership network includes representatives from the logistics industries, MNOs, service providers, public authorities, etc. Through 5G-LOGINNOV, ERTICO aims to expand its network of Start-Ups and also the scope of the Start-Ups market opportunities for the ERTICO Start-Ups Initiative. In addition, the information on the successful deployment of 5G-based services in freight and logistics will support ERTICO's transport and logistics roadmap. Therefore, the main result for ERTICO due to the participation in 5G-LOGINNOV consists in the **strengthening of the ERTICO Start-ups Initiative and the support of ERTICO's Transport and Logistics roadmap[1].**

The ERTICO Start-ups Initiative facilitate access of the start-ups to ERTICO's strong and consolidated network of Partners and works with Europe's thought leaders in smart mobility. This will allow them to create exposure and take advantage of opportunities with private and public stakeholders in the ERTICO Consortia preparations of EU-funded project proposals; and liaise with established brands in the automotive and smart mobility sector.

ERTICO's aim in Transport & Logistics is to increase interoperability, and connectivity in the optimisation of cargo flows, and to facilitate supply chain management, whilst making better use of existing resources. As reflected in the roadmap, by 2035, ERTICO's goal is to achieve seamless logistics and freight transport and nearer to 2025, achieve full digitalisation and automation of freight and logistics operations.

During the project, the ERTICO Network of Start-ups has been continuously updated with the latest 5G-LOGINNOV news and events to show the project's achievements. The 5G-LOGINNOV Open Call for Innovative Start-ups has also been actively disseminated to this group. Furthermore, the results of the project could potentially support ERTICO's goals reflected in the Transport and Logistics roadmap. In addition, the lessons learnt gathered through the development of the policy recommendations, are known as part of the organization's knowledge and will be further exploited in future projects related to 5G.

5.2 AKKODIS

AKKODIS, as a consulting and engineering company, expects to use the results of 5G-LOGINNOV as a set of reference solutions when proposing the development and integration of smart and collaborative

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[1] https://ertico.com/focus-areas/transport-logistics/

systems for connected and automated operations in smart cities, railway stations, airports, and harbours. To be more specific, the main results generated during the projects are the **updates of AKKODIS data collection tools.**

During the project, not only these tools have been improved incrementally to be able to face LLs peculiarities, but also AKKODIS provided guidelines, and organised workshops to facilitate their usage in LLs (references to 5G-LOGINNOV test have been included in the company's Marketing documentation).

The lessons learnt on data handling and cyber security will be used in the future for producing recommendations and white papers. Moreover, the updated tools constitute a demonstrator to be exploited as a reusable brick for other companies' initiatives.

5.3 CIRCLE

CIRCLE is a consultancy and engineering company providing process and management consulting services, innovative technological solutions and digital marketing support for the transport and logistics sector. The company's main ambition with 5G-LOGINNOV was to establish new business relationships and partnerships with stakeholders, especially with SMEs and start-ups involved in the project. In this vision, the main result achieved by CIRCLE/Magellan was the expansion **of the Docks the Future Network of Excellence.**

During the project in fact the Dock of the Future Network of Excellence has been promoted to new actors, in particular with the start-ups that won the 5G-LOGINNOV Open Call for Innovative Start-ups. In the future, the plan is to keep promoting the activities organised within the Docks in the context of the Future Network of Excellence. Such activities will be also addressed to the established Network of Start-ups defined in Section 4.

Furthermore, CIRCLE/Magellan aims to exploit the collaboration and the knowledge generated in 5G-LOGINNOV in new EU-funded projects.

5.4 CONTINENTAL

Continental develops pioneering technologies and services for sustainable and connected mobility of people and their goods. The aim of Continental as part of the 5G-LOGINNOV project is to showcase the applicability of its 5G telematics products in the logistics sector, as well as to evaluate the performance of its devices in various network conditions, with a particular focus towards 5G-SA networks.

In this framework, the **usage of CONTINENTAL's 5G Telematics products in the logistics sector** represents an important result for the company that has been achieved thanks to 5G-LOGINNOV. During the project, CONTINENTAL's 5G Telematics devices have been installed in vehicles operating around Hamburg, with the aim of collecting fuel consumption, acceleration, and speed information, as well as location data. Several field tests performed, in both single vehicle, and platoon formation, with the aim of seeing changes in fuel consumption. All data collected from device in a backend database. After the end of the project, the company plans a continuous development of devices, with the aim of gathering more types of information from vehicles (e.g., vehicle health). Furthermore, Continental is willing to integrate 5G Telematics devices into other vehicles, both for freight and for people transport.

Another relevant result for Continental is represented by the **understanding of the outcome of the application of 5G Telematics products in various network conditions.** During the project, 5G Telematics devices have been used in various real-life network conditions (5G NSA) to see the performance of device within the project scopes. In the future, the company expects to undertake continuous testing and evaluation of devices in other 5G networks, extending to 5G SA networks.

Furthermore, newer versions of 3GPP, with focus on content that is relevant for automotive sector, will be evaluated.

5.5 ICCS

Being a research organisation, ICCS' primary interest and objective in 5G-LOGINNOV was the **acquisition of further expertise and know-how in the field of 5G, IoT and relevant ecosystem technologies in the logistics and ports domain.** Specifically, through the project, ICCS extended its technological expertise and know-how in what concerns the deployment, integration, testing and evaluation of advanced 5G technologies, IoT applications and services on top of private 5G infrastructures, with a particular focus on the logistics domain within an industrial environment such as Ports. This has helped ICCS develop a substantially improved understanding of experimental activities in the field of telecommunications such as 5G, IoT and other ecosystem technologies such as MEC, virtualization, management and orchestration, adding to the long track record of the research team in the broader research domain. The accumulated knowledge has already provided ICCS researchers the opportunity to develop their activities in the broader area of 5G. For instance, new MSc and PhD students had the chance to get in touch with the topic. In the future, ICCS will keep pursuing the application of this knowledge and the attainment of more expertise in the domain of 5G, virtualization, AI/ML and relevant ecosystem technologies for further research activities in various European research initiatives, e.g., HORIZON EUROPE. Part of this knowledge is already applied within the 5G-IANA Project (https://5g-ppp.eu/5g-iana/), which is coordinated by ICCS, with main focus on 5G technologies, virtualization, AI, as well as management and orchestration tools in CCAM applications, and within the CONNECT Project (https://horizon-connect.eu/), with main contributions regarding orchestration and virtualisation tools such as Kubernetes for CCAM applications.

A next point of interest for ICCS in 5G-LOGINNOV is expanding the expertise (know-how) of the group in developing AI-enabled video analytics services. Therefore, the **Research and Development on Computer Vision Analytics Services** performed in 5G-LOGINNOV is an additional important result. Towards this direction, ICCS has developed a set of use cases, focusing on computer vision and AI/ML methodologies, software and tools, for developing applications focusing on logistics, as well as security/safety services in a Port environment, with core contributions on the development, integration, testing and validation of AI-assisted video analytics services in such industrial environments. After the end of the project, ICCS will keep pursuing the application of this knowledge and the attainment of more expertise for further research activities in various European research initiatives.

5.6 ICOOR

ICOOR is an Italian research centre that behaves as the Cluster of experts in the area of Operations Research. ICOOR will use the knowledge generated through 5G-LOGINNOV for generating new research and innovation projects related to 5G, ITS, transport and logistics, smart city and opportunities within Horizon Europe and Digital Europe. Other EU programmes addressing SMEs will also be considered. Furthermore, a strong interest is in the establishment of new strategic partnerships with industry actors (especially SMEs and start-ups).

Therefore, the main result obtained by ICOOR during the project that facilitates reaching the above-mentioned scopes is the creation of a **customised approach for the GUEST methodology**, that is enriched with 5G and start-ups' related lessons learnt.

During the 5G-LOGINNOV duration, the updated methodology has been showcased during relevant events, such as the COMPSAC 2022, ITS EU Congress 2023 in Lisbon and IPIC Congress 2023. Moreover, two proposals under the 6G-SNS umbrella have been developed, exploiting this approach.

The customised approach for the GUEST methodology will be exploited in further projects involving innovative technologies for logistics hubs.

5.7 INTERNET INSTITUTE

Internet Institute is an innovation-intensive SME, highly specialized in the 5G, IoT and cloud solutions. Internet Institute aims to get knowledge gains from the 5G-LOGINNOV project, aiming at obtaining a competitive advantage for future technological improvements of its products and of specific technologies built on those products. To be more specific. based on the common outputs of the Koper Living Lab (mentioned in section 2.3), Internet Institute wishes to benefit from higher knowledge on supporting complex processes in logistics and port domain using 5G, IoT and related technologies. As well, Internet Institute expects to establish a long-term partnership with the 5G-LOGINNOV partners. The expectation has been satisfied, as Internet Institute can count on the availability, through the project, of three important results. First, the **improvements of the private 5G mobile system (K.1)** have to be mentioned**:** the outcomes have been presented and demonstrated at multiple conferences, including industrial ones. It has been also recognized by multiple vendors; therefore, possibilities of technology transfer are also in progress. Similarly, the **improvement of the Industrial 5G IoT System (K.2)** is to be considered as an important result for Internet Institute; it has been exploited (and further upgraded) within multiple research projects – Int5Gent, 5GASP, 5G-INDUCE, 5G-IANA, EVOLVED-5G and during several conferences. The upgraded Private and Industrial 5G systems have been developed jointly with the other Koper LL partners and constitute LL's jointly developed exploitable results. The future exploitation is going to be part of a common strategy but, at the individual level, it will occur by means of further dissemination and continuous discussions with industrial partners (i.e., vendors) on their possible integration into existing products. Finally, the **improvement of Quality assurance services for 5G networks and cloud-infrastructure designed for ports and industry 4.0 environment** is an important result with exploitation potential, as verified during the 5G-LOGINNOV project, when it has been utilized in the Piraeus port (Athens LL), as a part of cross-pilot demonstration. Next, it will be exploited within the VITAL-5G project (port of Antwerp); furthermore, it is planned to be integrated as a new feature into existing Internet Institute products already available in the market.

5.8 LUKA KOPER

Luka Koper is the Port of Koper, where the Slovenian LL takes place. The port's ambition with 5G-LOGINNOV is on testing and validating new technologies and processes that will expectedly substitute current business models. Specific exploitation goals are: technological knowledge in the 5G environment focusing on critical communications and useful technologies and applications for the seaports and multimodal hubs; customising existing business processes to future state-of-the-art technologies and definition of future business models by setting up the corresponding time-aligned approach; strategic partnerships with stakeholders, including in the research field in EU; to exploit opportunities for future commercial collaborations.

Accordingly, the main exploitable result that the Port of Koper has achieved is the new **Collaboration Model for implementing 5G-enabled technologies.** During the project, the model has been presented at multiple conferences mainly focused to the target industry and – in the future – it is expected to be exploited within new research projects, ideas and innovations that cater to the various needs of the daily port operations at the Port of Piraeus.

Finally, Luka Koper will get benefit from the exploitable results generated jointly in the Koper LL, i.e., the **improved private 5G mobile system for use cases in port and logistics domain (K.1)** and the **Improved Industrial IoT System for specific needs of the ports and logistics domain (K.2).** For both, the exploitation approach is common at the LL level, and is described in section 2.3.

5.9 Piraeus Container Terminal

The Piraeus Container Terminal (PCT) is one of the leading container terminals in the Mediterranean region and – within 5G-LOGINNOV – hosts the Athens LL. Within the project, PCT is expected to benefit from the utilization of 5G and relevant cloud-edge ecosystem technologies to improve several aspects

in daily port operations such as improve the efficiency of port operations (including various port assets, e.g., trucks, quay side cranes), improve safety/security within the port premises of people and assets, reduce yard vehicles costs, automate operations aided though computer vision and AI/ML solutions at the far-edge. Additionally, the collaboration with relevant stakeholders will open new research and commercial opportunities/collaborations, enabling the port of Piraeus to further expand its expertise and market opportunities. Throughout the duration of the 5G-LOGINNOV project, PCT has been engaged in several dissemination activities where the work conducted at Athens LL has been presented to relevant stakeholders (e.g., Port authority, Terminal operators, etc.), SMEs, and other research projects. Throughout these initiatives the network of partners of the LL has been expanded, sharing expertise, best practices and lessons learnt from the various activities, creating opportunities for potential new collaborations and new research projects.

In line with the expectation, PCT can count on the achievement of important results that are mostly linked to the LL's activities. PCT will get high impact from the 5G-IoT Platform (A.1) that is part of the LL's exploitation plan described in section 2.1; and by the **Computer Vision Service for Daily Port Operations**. Throughout the development, integration, testing, and validation activities implemented during the 5G-LOGINNOV project, PCT has learned about all the pertinent technologies (5G, IoT, AI, MEC, virtualization, etc.) and how they can enhance the daily port operations (e.g., improve the efficiency of various operations by automating services, reducing costs, and improving the safety of employees). PCT will further invest in the ecosystem of 5G (and beyond) technologies and will continue to exploit the 5G infrastructure deployed during this project to support the daily port activities. It will also extend the 5G infrastructure to expand the network coverage to all the piers as during the project 5G coverage was limited to one of the piers (in total the port currently operates three piers with plans to further expand the Port area). According to the company's roadmap, PCT will further invest in research activities targeting new innovative solutions with aim to enhance the efficiency of logistics operations, enhance safety/security protocols, minimize costs by pursuing new research initiatives and future IA/RIA projects, e.g., for Project proposals under the Smart Networks and Services Joint Undertaking (SNS JU). Additionally, the developed 5G-IoT platform and developed 5G&AI-enabled video analytics services will be further developed and enhanced to support industrial grade services, in daily port operations. An activity already underway is to further train the AI services to increase the accuracy of the predictions provided by the ML services for the container seal detection and human presence (UC3, UC4 and UC5)

5.10 SWARCO

Business fields of the SWARCO companies are, among others, traffic light controllers (TLC), traffic management centres (TMC), software for planning and evaluation of the traffic logic controlling intersections as well as the generation of traffic logics. This expertise enables to access the traffic logic process data either locally (TLC) or centralized (TMC) and to calculate a prediction locally e.g., inside the TLC or a C-ITS-roadside unit, or inside the TMC and disseminate the forecast as required for external usage. The interest of SWARCO in 5G-LOGINNOV is - hence - to upgrade its services according to the 5G-enabled opportunities: by its high bandwidth and low latency, 5G may enable the exhaustive, real-time and bidirectional communication between traffic management infrastructures and road users without the need for dedicated devices like specialised on-board units.

Consequently, SWARCO will use lessons learnt with the 5G-LOGINNOV experience to improve the road users travel experience by making it faster, safer and more environmentally friendly, and to provide road operators with more detailed and up to date insight into the traffic situation. In this direction, two are the main exploitable results. First, the **standardised version of data format for traffic light forecast** has been set up. This system has been exploited during the project to produce, collect and use traffic light forecast information in the context of the Hamburg LL. This result will be further exploited for future productions. Also, the **mechanism to enable cities' traffic management to work with emission data originating from vehicles** implemented in 5G-LOGINNOV is considered an exploitable result. During the project, the existing knowledge in the topic has been enriched with increased understanding of the different data handling processes with respect to emissions. In the future,

SWARCO will modify current systems to accept vehicle-based emission data, according to the mechanisms tested in the project and, especially, collaborating with T-Systems.

5.11 TEC4U

TEC4U is an automotive industry service provider covering all product design requirement compliance issues. One of the main research topics is the cost and emission optimization of commercial vehicle fleets; in this field the company combines engineering expertise in vehicle dynamics and competence in the field of hardware and software development. TEC4U owns the vendor neutral and open telematics and telemetry system Entruck that serves as a telematics and analytics platform for commercial fleets, commercial tyre manufacturers and tyre dealers with the goal to reduce emissions and wear of commercial vehicles during their use phase and so to increase the efficiency of logistic operations.

As Entruck serves as an analytics platform and hub that connects vehicles with backend stakeholders with various interests, TEC4U is interested in the implementation of 5G functionalities in their hard- and software to increase and optimize the connectivity with the moving asset – the vehicle. The main focus lies on a high band width, a low latency and high reliability of the connection.

Based on the TEC4U ambitions, their experience in 5G-LOGINNOV, mainly within the activities of the Hamburg LL, was a success in terms of achievement of exploitable results. An **extension of the Entruck model** was possible during 5G-LOGINNOV, by including the Low Carbon Mobility Management (LCMM) by T-System, allowing a comparison with real-time Canbus data to be implemented, and the application of the ISO-23795 standard, allowing for a harmonisation of measurement approaches and acting as reference for the evaluation of the fuel consumption. To exploit the extended version of the Entruck model, TEC4U plans the integration into the existing product environment in the company portfolio; more specifically, TEC4U, in collaboration with T-System (owner of the LCMM system), plans to develop a prototype for the implementation of LCMM collected data in Entruck, that will be included it in the product portfolio of both TEC4U and T-System.

Thanks to 5G-LOGINNOV, TEC4U has also obtained a deeper understanding of technical V2X constraints, i.e., regarding 3D positioning accuracy, and new knowledge related to frequency allocation and use in 5G/6G spectrum standardization as well as precise. This will also contribute to preparing Entruck for the next generations V2X communication within the 5G infrastructure.

5.12 TELECOM SLOVENJE

Telekom Slovenije (T-SLO) is a global expert and leading provider of mobile broadband critical communications in Slovenia with a strong interest in consolidating itself as an expert and advanced 5G provider. The results of 5G-LOGINNOV will be directly used as input for planning T-SLO's future architecture including access, core, and service networks topology, as input for product development, to plan further services and to establish verticals partnerships, and as marketing activities to early engage and motivate existing and potential customers for new services. The latter will be implemented from the diversity of internal audiences, end business customers and verticals business partners.

According to the T-SLO goals, the 5G-LOGINNOV project was successful in helping the company obtaining some important results, such as the **Improvements of the Public 5G mobile network.** During the 5G LOGINNOV Project, especially thanks to the activities undertaken in the Koper LL, T-SLO improved the design, implementation, testing and operation of the Public 5G mobile network according to the needs of the port and logistics vertical in cooperation with local partners to better understand the issues and design the solution to fit specific requirements. The goal is exploiting the improved Public 5G network for improvements in the product portfolio, developing new customised solutions, implementing new test/verification, broadening the spectrum of topics provided to customers during consulting, training and educational services, further business development.

The project also allowed to define **new business models for campus 5G networks: during 5G-LOGINNOV**, the Koper LL served as reference business model, helping to investigate and shape the future of the vertical with 5G network technologies. The new 5G-enabled business model will be further exploited in the field of mobile services for the needs of industrial verticals, such as ports and logistics.

Finally, the project allowed T-SLO to obtain **increased expertise in the field of 5G networks, logistics and transport industrial vertical that will be exploited since** TSLO participates in other Horizon projects (e.g. ICT-41-2020: 5G-IANA) where knowledge and know-how from 5G-LOGINNOV will be exploited for further actions. T-SLO plans to further expand its expertise on ecosystem technologies relevant to 5G networks, edge capabilities (MEC) and IoT for future innovation actions.

5.13 T-SYSTEMS

T-Systems is one of the leading providers of digital services in Europe and, more specifically, ICT provider in large airport operators, e.g., Frankfurt a. M. and the Beijing's new 2nd capital airport. Additionally, T-Systems oversee innovative pre-port parking solutions in Hamburg and the development of Dynamic Slot Booking solutions in Bremerhaven. 5G-LOGINNOV is therefore considered by T-Systems as an important strategic approach for addressing vertical industries, i.e., in the port logistics domain. The main goals for T-System are therefore to establish new business ideas in the context of port logistics.

The 5G-LOGINNOV experience satisfied all expectations and led to the generation of important business results, such as the **upgraded version of the Low Carbon Mobility Management (LCMM) system** that could benefit both on the collaboration with TEC4U and with SWARCO.

The upgrades of the LCMM obtained with the collaboration with TEC4U have been exploited in the Hamburg LL, but also during the cross-pilot activities with Koper and Athens LLs. In the future, T-System and TEC4U are planning to co-develop a prototype for carbon footprint monitoring based on Entruck, LCMM and ISO standard for ETS-2 projects according to European directives.

The upgrades of the LCMM developed in collaboration with SWARCO are based on the combination of the LCMM and GLOSA services. In 5G-LOGINNOV the combination of the two technologies have been used for Vulnerable Road User protection (VRU) within the Hamburg test field and successfully deployed and showcased during ITS World Congress 2021 in Hamburg. In the future, T-SYSTEM will explore opportunities for joint VRU protection go-to-market activities together with ERTICO ITS Europe. Working with SWARCO on GLOSA traffic management solutions along logistics corridors and 5G will allow T-systems to expand their product portfolio and to increase their international market share.

In 5G-LOGINNOV, T-System has also led the design of a **5G Cloud based IOT Gateway for Logistics Corridor Management and CO_2 reduction** applying ISO-23795. During the project, it has been exploited in data evaluation activities for saving fuel and emissions. The applied ISO standard was found an overarching data analytics tool for these platforms. During the project, the 5G-IoT gateway data format was pre-defined. The plan for the future is to continue the study and go-to-market activities.

Finally, 5G-LOGINNOV allowed developing a **5G enabled City-Logistics and eXtended BRT project for C-I.T.S. Emission Trading (CDM).** Based on the measured improvements of 17% CO2 reduction, the potential in carbon savings for smart city traffic management was examined and found to be of value for the upcoming emission trading system (ETS-2) of the European Commission. In the future, T-Systems aim to align the results in carbon savings with the political roadmap for introducing ETS-2 across Europe and link it to the environmental agencies.

5.14 VICOMTECH

VICOMTECH is a leading research centre located in the Basque Country, generating innovation by creating new technologies wherever there is a market opportunity. VICOMTECH is interested in the integration of new functionalities and APIs in Standard Development Kits (SDKs) that are currently licensed and exploited in different success stories involving products from Tier 1 automotive companies and logistics systems for airports and public transport hubs. VICOMTECH aims at maintaining an active position as reference agent in Spain in research and development activities in sensor fusion based position calculation for automotive domains. As a private non-for-profit research centre, VICOMTECH transfers technologies to the ICT industry, through licensed SDKs and will exploit outputs in commercial relationships with its customers. In summary, with 5G-LOGINNOV, VICOMTECH's goal is to extend their expertise in computer vision and sensor fusion with leading edge technology and scientific developments. Furthermore, VICOM will support strengthening the competitiveness of their customers (SMEs) in the global market.

Thanks to the project, VICOMTECH could achieve a relevant **Knowledge gain in AI/ML applied to logistics.** Such increased knowledge was exploited in studies and research linked to multiple topics, such as: scale match for Tiny Person Detection, automated image-based container inspections, building synthetic simulated environments for configuring and training multi-camera systems for surveillance applications, automatic container code recognition via Faster-RCNN, and adaptive deep learning framework for shipping container code localization and recognition. In the future, VICOMTECH aims to continue research collaborations on similar topics with Universities and Research Centres.

In addition, during the project VICOMTECH developed **Seafront – Synthetic Dataset for Visual Container Inspection.** Python scripts have been developed that leverage Blender to generate synthetic datasets tailored for training deep-learning models designed for cargo-container inspection processes. Python scripts will be used to implement datasets (generate more synthetic datasets) and data collection capabilities within the ports and logistics centres. The datasets built within the project are already available (not for commercial purposes) for the scientific communities. The datasets will be used to make further research and implement knowledge.

5.15 VODAFONE INNOVUS

Vodafone Innovus is an innovative end-to-end IoT solutions provider and a fully owned Vodafone subsidiary. Always pushing the boundaries of innovation by developing cutting edge solutions, Vodafone Innovus is widely recognised by several market intelligence providers as a significant partner of Vodafone Global IoT, offering IoT customer solutions on a global scale. 5G-LOGINNOV will reinforce Vodafone's solutions portfolio by offering specialized edge-supported services that are not yet present in Vodafone's portfolio.

The 5G-LOGINNOV project allowed the company to **upgrade the Vodafone Innovus IoT Platform with ML capabilities on 5G enabled edge devices**, mainly enhancing the platform with new sensor types from complex devices (like processed video). During the project the upgraded tools has been exploited in the context of the Athens LL. In the future, Vodafone Innovus plans to include the knowledge gained into new development life cycle and products in general.

6   CONCLUSION

This deliverable represents the outcome of the final activities performed within T5.3 "Exploitation". Specifically, it provides an overview of the LL contexts, defining the linked KERs and the recommended business strategies, and clarifies the transferability potential of each KER resulting from the LLs. Moreover, it defines the exploitation strategy for the "Horizontal" KERs, i.e., those linked to the parallel research activities. Finally, the document reports the 5G-LOGINNOV individual partners' exploitation strategies.

Based on the assessment of the exploitation strategies of the 10 technological KERs developed in the three Living Labs (Athens, Hamburg, and Koper), and by considering the business strategies defined for each LL, it is possible to conclude on the main common recommendations. All three Living Labs recognize the fundamental importance of **5G technology as the backbone** infrastructure for their innovations. 5G enables real-time data collection, exchange, and communication, which will be vital for optimizing port and logistics operations. They aim to **optimize port operations** through the deployment of 5G technology and related innovations. This optimization includes improving efficiency, reducing downtime, enhancing safety, and increasing overall operational effectiveness. The three Living Labs **prioritize data** collection, analysis, and sharing. They harness data to make informed decisions, enhance visibility, and streamline processes within the port and logistics domains. In all cases, **complementary technologies** such as AI, ML, IoT sensors, and high-definition cameras are going to be integrated with 5G networks. This integration will enhance the capabilities of the systems and will enable real-time monitoring and analysis. **Safety and security** are common objectives across the Living Labs. They leverage 5G and related technologies to improve safety conditions for port personnel, detect potential sources of risk or non-compliance, and enhance security through surveillance systems. **Sustainability goals** are shared among the Living Labs. They aim to reduce negative externalities such as emissions, traffic congestion, and potential incidents, aligning with local, national, and European sustainability objectives. All three Living Labs will be exploring new revenue models beyond the 5G-LOGINNOV project (during which the main revenue source was the EU funding). They will consider various sources of revenue, including **usage and licensing fees**, which will be based on the innovative solutions they develop and deploy. **Collaboration** with a variety of new stakeholders, including new port authorities, logistics operators, public authorities, and technology providers, will be essential in all three Living Labs. Each Living Lab will acknowledge potential barriers to the adoption of their solutions, such as regulatory challenges, user reluctance, and competition.

When it comes to the assessment of the transferability potential of the technological KERs, it is possible to identify the main scopes motivating external stakeholders to adopt these technologies. In facts, they are willing to: enhance safety and security measures, improve operational efficiency, achieve cost reduction, promote environmental sustainability, and facilitate digital innovation and collaboration throughout the port ecosystem. The main risks and blockers for scaling up these technologies include the **significant infrastructure investments** required for 5G implementation, **potential customer reluctance** to embrace new technologies, **intricate implementation processes** and **regulatory variations** in different regions. Additionally, some technologies face challenges in recognizing their value proposition, and there are concerns about the suitability of certain technologies for the complex port environment. The critical success factors and enablers for scaling up these technologies encompass the **establishment of cooperation or federations among logistics operators** to create a genuine digital port ecosystem. Furthermore, fostering **digital innovation** throughout the port and engaging in **lobbying activities with governmental institutions** are seen as pivotal for their successful adoption. The availability of **real-time and large-scale data processing capabilities** also plays a significant role in facilitating the scalability of these technologies.

The 5G-LOGINNOV project has achieved significant outcomes that extend beyond specific technologies, resulting in **Horizontal KERs** with the potential to contribute to knowledge, research, and innovation. These "Horizontal" KERs, not tied to specific Living Labs, have a broad reach and can impact the wider field of 5G technology and its applications. They foster collaboration and innovation across

different areas, emphasizing their cross-cutting nature. The main strategies to exploit them are mostly linked to **future research and innovation activities**, for instance within new EU-funded projects, or **leveraging the collaborations** with relevant project partners for **enhancing their uptake at the industrial level**.

Based on the accomplishments and **plans of the 5G-LOGINNOV project partners**, key recommendations can be made to further leverage the success of the project and advance the use of 5G technologies in logistics. In general, 5G-LOGINNOV partners shall continue **pushing for continuous product innovation**. The incorporation of ML capabilities on 5G-enabled edge devices, into new product development, and the enhancing of capabilities of IoT platforms, will lead to a competitive advantage. It is recommended to highlight the significance of V2X communication and promote its integration into product portfolios to enhance logistics efficiency and safety. Furthermore, partners should continue upgrading and expanding their systems, collaborating with others to align with European Commission regulations. **Data sharing to further develop AI/ML applications** in logistics shall be encouraged, for instance by providing datasets to scientific communities for research purposes. The importance of data collection and analysis to optimize logistics operations shall be emphasised. Partners should continue developing standardized data formats and mechanisms, facilitating better integration into existing products and systems for more efficient traffic management. In addition, partners should actively contribute to the development of 3GPP standards for 5G in logistics, ensuring interoperability and compatibility across different 5G networks. The project provided evidence that the **adoption of new business models can enable innovation in port's logistics**: Partners should continue exploring new business models for 5G networks, to drive product improvements and consulting services expansion. Specifically, port Infrastructures shall be encouraged to invest in extending network coverage, researching new technologies, and collaborating on innovative solutions to enhance port operations. In this direction the adoption of collaboration models, for implementing 5G-enabled technologies in port operations, encouraging other logistics hubs to follow suits. It is also recommended to continue the **collaboration and knowledge sharing among partners**, emphasizing the importance of cross-industry partnerships to drive innovation. Partners should continue expanding and nurturing start-ups to infuse fresh ideas and technologies into the logistics sector. The importance of long-term partnerships and support for complex logistics processes using 5G and IoT technologies must be emphasized. Finally, partners shall actively explore opportunities for new EU-funded projects, leveraging the success and expertise gained through 5G-LOGINNOV. The gained expertise in 5G, IoT, and AI-enabled analytics can be applied to participate in and lead research activities in European initiatives, driving innovation in the logistics domain.

ANNEXES
ANNEX 1: TRANSFERABILITY OF 5G-LOGINNOV TECHNOLOGICAL RESULTS - SURVEY

Transferability of 5G-LOGINNOV technological results

The 5G-LOGINNOV Project main aim is to design an innovative framework addressing integration and validation of CAD/CAM technologies related to the ports domains by creating new opportunities for LOGistics value chain INNOVation.

Thanks to the new advanced capabilities of 5G relating to wireless connectivity and Core Network agility, 5G-LOGINNOV Living Labs 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 domains, thus being a pillar of economic development and business innovation and promoting local innovative high-tech SMEs and Start-Ups.

5G-LOGINNOV promising innovations are key for the major deep-sea European ports in view of the mega-vessel era (Hamburg, Athens), and are also relevant for medium sized ports with limited investment funds (Koper) for 5G. This survey is related to the project activity T5.3 (Exploitation) and aims to assess the potential transferability of the 5G-LOGINNOV technological results in other contexts.

For more information about the project check out the project's website: https://5g-loginnov.eu/

Section 2: Information about the respondent

Which organisation type do you represent?

- Public Authority / City / Region
- Telco operator
- Port Authority/Terminal Operators.
- Test and Certification
- Research Center/University
- Logistics/Professional/Industrial Association
- Transport Operators
- Logistics service provider/Transport service provider
- Other

In which Country is your organisation located?

Which is your organisation's size?

- Micro enterprise (<10 employees)
- Small enterprise (<50 employees)
- Medium-sized enterprise (<250 employees)
- Large enterprise (>250 employees)

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 particular, in the port domain?

- Yes
- No

If Yes, please provide a brief description of the context

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

- Yes
- No

If yes which one?

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

- Yes
- No

If yes which one?

Section 3: Introduction to 5G-LOGINNOV technological results

5G-LOGINNOV provides the three Living Lab (Athens, Hamburg, Koper) with the possibility to develop and implement innovative logistics applications thanks to the usage of the 5G-enabled network. During the project, the three Living Labs are expected to introduce, deploy and test the following main technological results.

In Athens:

- **5G IoT Platform in Port Operations**: *deployment of a network management and service orchestration platform based on Opensource MANO (OSM), an ETSI-hosted software stack aligned with ETSI NFV, and Kubernetes orchestration engine for the lifecycle management of cloud native applications and virtualization technologies. The main focus of the 5G management platform is the automatic software deployment of AI/ML and computer vision applications (e.g., AI/ML aided cargo container seal detection and human presence detection) tailored to Port operations, enabling service control, monitoring and management at scale. The platform's objective is to improve the efficiency of port operations, personnel and asset safety, as well as the reduction of operational costs.*
- **5G&AI-enabled container seal detection for supporting logistics process:** *development of a 5G&AI/ML-enabled video analytics service, exploiting high resolution cameras deployed at the quay side cranes of the port, in order to detect the presence/absence of cargo container seals, at the loading/unloading process of vessels. The proposed solution is based on two AI/ML models working sequentially; the former detects containers in 4K uplink video streams transmitted over 5G, whereas the latter detects the presence/absence of seals on the container's surface/door. The proposed solution (inference service engine for container seal detection) is packaged and deployed as cloud native network functions at the edge, with NFV-MANO support, to facilitate ease in monitoring and lifecycle management operations, at scale. The automated service of container seal detection is of paramount importance for a Port operator as it verifies the integrity of a container's content, and thus the Port's liability in case of violations.*

- **5G&AI-enabled human presence detection to support safety/security operation**: development of AI/ML-based video analytics services, exploiting high resolution cameras deployed on 5G trucks, and on other stationary locations at the Port premises. The proposed innovation delivers a collision avoidance/alert system between trucks and personnel for cameras equipped on trucks, as well as human presence detection service from stationary 5G cameras tailored to security/safety applications, e.g., for people entering restricted or high-risk areas. The proposed solutions (inference service engine for human presence detection and collision avoidance system) are packaged and deployed as cloud native network functions at the edge, with NFV-MANO support, to facilitate ease in monitoring and lifecycle management operations, at scale. The proposed service targets safety and security applications at the Port premises.

- **5G Truck Fleet Management Platform**: this technology takes the bird-eye-view parking concept of vehicles into a new level by leveraging a 5G video feed from other vehicles. The scenario uses the concept of video teleconference but implemented for truck drivers. Each truck is fitted with a 5G based mobile phone with the front camera facing the street. Then the camera feed is broadcasted, along with location info, real time to the adjacent truck (installed mobile phones). This gives an additional surrounding live video and the ability for a driver to view the truck while manoeuvring during parking.

In Hamburg:

- **5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems:** FTED consists of collecting speed profiles, linking them to the driving reference cycle (WLTP) and measuring the %-deviation relative to the cycle. The methodology is described in detail in the ISO-23795 standard. The fleets are collecting data about carbon emissions as well as information about stop-and-go, acceleration and energy demand of the vehicle. Based on the speed profiles per vehicle, a classification of the trip, congestion and driving behaviour is reported as well as the quantity of additional carbon emissions relative to the standard. Together with the traffic volume known and published by the City of Hamburg, this allows to quantify the emissions of carbon dioxide in each area and road network.

- **5G enabled GLOSA (Green Light Optimal Speed Advise):** The technology gives drivers some advice for best speed choices when crossing intersections using timeframes of "green, yellow and red". Additionally, GLOSA allows the vehicle to choose speed ranges which helps to avoid collisions caused by crossroads, a challenge for any automated vehicle moving in an urban and complex road network.

- **5G enabled Collision Warning**: This technology is applied for collision alerts for vulnerable road users approaching the intersection as well as for collision alerts for vehicles platooning. In combination with GLOSA, a direct message is sent to the 5G smartphone App via MobileEdge computing ensuring ultra-reliable low latencies possible only in the 5G network. The technology is urgently needed in all kinds of urban environments where autonomous vehicles are connected to a given road infrastructure existing from variable message signs, traffic lights or other traffic management functions and features (cellular V2X).

- **5G enabled Carbon Emission Trading**: The database allows to exactly determine the amount of carbon emissions caused by the logistics fleets working on the supply chain in the maritime and aviation sector. By measuring the trip-based amount and by knowing the influence of certain traffic management activities (e.g., gate control, access control or park guidance management), the infrastructure operator has the opportunity to improve the overall emission situation and to clearly identify the carbon emissions caused by certain traffic and traffic management activities.

In Koper

- **Improved private 5G mobile system for use cases in port and logistics domain**: While general solutions usually miss certain specific requirements needed to correctly address business processes, this solution will incorporate specific network and services customizations and adaptations to meet business KPIs required by ports/logistics domain which will be studied and examined throughout the 5G-LOGINNOV project in cooperation of technology and business domain experts.

- ***Improved Industrial IoT System for specific needs of the ports and logistics domain***: *This technology will ensure secure, resilient and QoS guaranteed 5G connectivity for non-5G IoT devices, e.g., various sensors, cameras, etc., and will be improved by several technical innovations. Based on an upgraded hardware platform, 5G NSA and SA mode of operation will be supported and a cloud-native approach will be introduced for the Industrial IoT System's software components. This will allow for automated deployment (either on far-edge, edge or core IaaS, depending on specific requirements), onboarding, scaling, self-healing, etc. The cloud-native approach will also result in IaaS's readiness for the orchestration within the 5G ecosystem.*

Which 5G-LOGINNOV technological results result would better fit your context, in line with your innovation strategies?

- 5G and IoT Platform in Port Operations with NFV-MANO support (*if this option is selected go to the relevant section after*)
- 5G&AI-enabled (far-)edge video analytics service for container seal detection with NFV-MANO support (*if this option is selected go to the relevant section after*)
- 5G&AI-enabled (far-)edge video analytics service for human presence detection with NFV-MANO support *(if this option is selected go to the relevant section after)*
- 5G Truck Fleet Management Platform *(if this option is selected go to the relevant section after)*
- 5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems *(if this option is selected go to the relevant section after)*
- 5G enabled GLOSA (Green Light Optimal Speed Advise) *(if this option is selected go to the relevant section after)*
- 5G enabled Collision Warning *(if this option is selected go to the relevant section after)*
- 5G enabled Carbon Emission Trading *(if this option is selected go to the relevant section after)*
- Improved private 5G mobile system for use cases in port and logistics domain *(if this option is selected go to the relevant section after)*
- Improved Industrial IoT System for specific needs of the ports and logistics domain *(if this option is selected go to the relevant section after)*
- None of the above *(if this option is selected go to the section 15)*

Section 4-13: Transferability assessment (to be applied to each selected technology)

Which scope would this technology have in your context?

- Provide accurate communications and recommendations for operations
- Increase safety within port
- Increase security in port areas
- Increase efficiency of the operations
- Decrease costs for operation
- Decrease traffic and incidents
- Improve connections inside and outside the port
- Increase number of ITC services
- Degree of centralization of data and information sources
- Degree of data-driven and digitally automated processes
- Improve quality of working environment
- Increase economic wealth
- Increase businesses cooperation
- Decrease health risks for workers
- Increase resilience to climate change
- Other

If your wish, feel free to tell us more on the scopes.

Which needs are expected to be satisfied by this technology in your context?

- Automation of the container seal checking process
- Reduction of vessel stay at port premises
- Reallocation of human personnel in other tasks/jobs
- Expedite the unloading process of vessels.
- Increasing security
- Increasing safety
- Efficient human resource utilization
- Need to provide training to end users
- More information on traffic situation
- More information on fleet data
- Need for energy saving
- Need to reduce congestion
- Development of autonomous vehicles
- Improvement of environmental sustainability
- Cost reduction
- Other (specify)

If your wish, feel free to tell us more on the needs.

What are the main risks and blockers for scaling up this technology in your context?

- Floating vehicle data has the general risk of spatial and temporal coverage leading to unreliable statistics.
- Floating vehicle data is delivered by competitors, fleet operators and public authorities which prefer their own data types
- Complex implementation which requires an economic breakthrough and a joint go to market strategy.
- It is necessary to enable mass market and commodity smart phones with features compatible with the technology. The implementation of components in mobile devices may take several months, sometimes years to be accepted
- Considerable infrastructure investments for 5G
- Potential customers may not be yet ready or willing to adopt new technologies
- Market entrance barriers
- Specific regulation requirements in different regions
- Potential customers not recognizing value of the technology.
- The required algorithms are trained based on private datasets
- The required algorithms suffer (in general) from adversarial attacks, which may confuse the inference engine.
- The required algorithms work in general in a context aware fashion. Hence, the resultant accuracy might deviate in cases.
- The required algorithms suffer (in general) from adversarial phenomena, which are rare, but crucial in safety critical applications.
- The technology may not be sufficiently adapted to the needs or requirements of the complex port environment
- The technology may not be compatible with existing ICT infrastructure or not adaptable to port operating systems.
- Too many regulatory requirements and lengthy implementation procedures

- The technology is too much dependent on specific hardware/software components
- There may be difficulties in updating/upgrading software and services to implement the technology
- There can be delays in purchasing 5g network equipment
- There may be a strong dependence of customers on competitive connectivity technologies (Wi-Fi, fixed)
- Other (specify)

If your wish, feel free to tell us more on the main risks and blockers

Which of the following critical success factors are required for scaling up the technology in your context?

- Agile and coherent institutional chain
- Bargaining power of customers and users
- Cooperation/federation among logistics operators, aiming to create a true digital port ecosystem
- Creation of a trustable regulatory/organizational framework for sharing data yet protecting own business
- Degree of competition for attracting customers and investors
- Development of joint projects on R&D, green issues, safety and security, inland infrastructures
- Encourage digital innovation and collaboration throughout the port
- Green innovations in processes and facilities
- Influence of port multinationals on long-term port development and strategic decisions
- Joint marketing and communication activities
- Lobbying activity towards governmental institutions
- Market openness and selection of competitive private investors
- Presence of dedicated terminals ensuring a stable cargo base
- Preservation of port image and reputation
- Proactive hinterland strategies by Port Authorities governance framework and managerialization of the Port Authority
- Proactiveness and scope of Port Authority strategies
- Real-time and large-scale data processing
- Relations between local and international stakeholders and intensity of conflicts
- Respect of international green regulations
- Smooth city-port relationship and social stability and consensus
- Sustainable port planning
- Synchronization of sea-land operations
- Tailored landside infrastructures and inland connections/dry ports

If your wish, feel free to tell us more on the critical success factors

Please, mention any policy or regulation that is linked to the introduction of this technology in your Country and/or in Europe

Section 14: Transferability of other 5G-LOGINNOV technological results

Is there any other 5G-LOGINNOV technology that is potentially transferable to your context?

- **5G IoT Platform in Port Operations**: deployment of a network management and service orchestration platform based on Opensource MANO (OSM), an ETSI-hosted software stack aligned with ETSI NFV, and Kubernetes orchestration engine for the lifecycle management of cloud native applications and virtualization technologies. The main focus of the 5G management platform is the automatic software deployment of AI/ML and computer vision applications (e.g., AI/ML aided cargo container seal detection and human presence detection) tailored to Port operations, enabling service control, monitoring and management at scale. The platform's objective is to improve the efficiency of port operations, personnel and asset safety, as well as the reduction of operational costs. (*if this option is selected go to the relevant section before*)
- **5G&AI-enabled container seal detection for supporting logistics process:** development of a 5G&AI/ML-enabled video analytics service, exploiting high resolution cameras deployed at the quay side cranes of the port, in order to detect the presence/absence of cargo container seals, at the loading/unloading process of vessels. The proposed solution is based on two AI/ML models working sequentially; the former detects containers in 4K uplink video streams transmitted over 5G, whereas the latter detects the presence/absence of seals on the container's surface/door. The proposed solution (inference service engine for container seal detection) is packaged and deployed as cloud native network functions at the edge, with NFV-MANO support, to facilitate ease in monitoring and lifecycle management operations, at scale. The automated service of container seal detection is of paramount importance for a Port operator as it verifies the integrity of a container's content, and thus the Port's liability in case of violations. (*if this option is selected go to the relevant section before*)
- **5G&AI-enabled human presence detection to support safety/security operation**: development of AI/ML-based video analytics services, exploiting high resolution cameras deployed on 5G trucks, and on other stationary locations at the Port premises. The proposed innovation delivers a collision avoidance/alert system between trucks and personnel for cameras equipped on trucks, as well as human presence detection service from stationary 5G cameras tailored to security/safety applications, e.g., for people entering restricted or high-risk areas. The proposed solutions (inference service engine for human presence detection and collision avoidance system) are packaged and deployed as cloud native network functions at the edge, with NFV-MANO support, to facilitate ease in monitoring and lifecycle management operations, at scale. The proposed service targets safety and security applications at the Port premises. (*if this option is selected go to the relevant section before*)
- **5G Truck Fleet Management Platform**: this technology takes the bird-eye-view parking concept of vehicles into a new level by leveraging a 5G video feed from other vehicles. The scenario uses the concept of video teleconference but implemented for truck drivers. Each truck is fitted with a 5G based mobile phone with the front camera facing the street. Then the camera feed is broadcasted, along with location info, real time to the adjacent truck (installed mobile phones). This gives an additional surrounding live video and the ability for a driver to view the truck while maneuvering during parking. (*if this option is selected go to the relevant section before*)
- **5G enabled Floating Truck Emission Data (FTED) for Low Carbon Transport Systems:** FTED consists of collecting speed profiles, linking them to the driving reference cycle (WLTP) and measuring the %-deviation relative to the cycle. The methodology is described in detail in the ISO-23795 standard. The fleets are collecting data about carbon emissions as well as information about stop-and-go, acceleration and energy demand of the vehicle. Based on the speed profiles per vehicle, a classification of the trip, congestion and driving behaviour is reported as well as the quantity of additional carbon emissions relative to the standard. Together with the traffic volume known and published by the City of Hamburg, this allows to quantify the emissions of carbon dioxide in each area and road network. (*if this option is selected go to the relevant section before*)
- **5G enabled GLOSA (Green Light Optimal Speed Advise):** The technology gives drivers some advice for best speed choices when crossing intersections using timeframes of "green, yellow and red". Additionally, GLOSA allows the vehicle to choose speed ranges which helps to avoid collisions caused by crossroads, a challenge for any automated vehicle moving in an urban and complex road network.
- **5G enabled Collision Warning**: This technology is applied for collision alerts for vulnerable road users approaching the intersection as well as for collision alerts for vehicles platooning. In

combination with GLOSA, a direct message is sent to the 5G smartphone App via MobileEdge computing ensuring ultra-reliable low latencies possible only in the 5G network. The technology is urgently needed in all kinds of urban environments where autonomous vehicles are connected to a given road infrastructure existing from variable message signs, traffic lights or other traffic management functions and features (cellular V2X). (*if this option is selected go to the relevant section before*)

- **5G enabled Carbon Emission Trading**: The database allows to exactly determine the amount of carbon emissions caused by the logistics fleets working on the supply chain in the maritime and aviation sector. By measuring the trip-based amount and by knowing the influence of certain traffic management activities (e.g., gate control, access control or park guidance management), the infrastructure operator has the opportunity to improve the overall emission situation and to clearly identify the carbon emissions caused by certain traffic and traffic management activities. (*if this option is selected go to the relevant section before*)

- **Improved private 5G mobile system for use cases in port and logistics domain**: While general solutions usually miss certain specific requirements needed to correctly address business processes, this solution will incorporate specific network and services customizations and adaptations to meet business KPIs required by ports/logistics domain which will be studied and examined throughout the 5G-LOGINNOV project in cooperation of technology and business domain experts. (*if this option is selected go to the relevant section before*)

- **Improved Industrial IoT System for specific needs of the ports and logistics domain**: This technology will ensure secure, resilient and QoS guaranteed 5G connectivity for non-5G IoT devices, e.g., various sensors, cameras, etc., and will be improved by several technical innovations. Based on an upgraded hardware platform, 5G NSA and SA mode of operation will be supported and a cloud-native approach will be introduced for the Industrial IoT System's software components. This will allow for automated deployment (either on far-edge, edge or core IaaS, depending on specific requirements), onboarding, scaling, self-healing, etc. The cloud-native approach will also result in IaaS's readiness for the orchestration within the 5G ecosystem. (*if this option is selected go to the relevant section before*)

- No, there is no other 5G-LOGINNOV technology would fit my context. (*if this option is selected go to section 15*)

Section 15: Privacy and GDPR

Personal Data Protection Information

Participation to this survey is completely voluntary. Please read the information about the project, its aims, and the gathering of user requirements and needs and ask questions about anything that you do not understand.

Introduction to the 5G-LOGINNOV Project

In the context of the European Union's Horizon 2020 Programme, the 5G-LOGINNOV project has received funding under Grant Agreement No. 957400 (Innovation Action), which was signed between ERTICO-ITS Europe (ERTICO) and the 5G-LOGINNOV Consortium.

Purpose of data collection

This survey relates to a preliminary analysis of the stakeholders' willingness to join the future developments. Your personal details will be collected by the 5G-LOGINNOV consortium members via this questionnaire.

Types of data collected

The personal data that will be collected during this activity includes the name, email address and organisation of participants.

Data storage and retention

Your personal data will be collected by the 5G-LOGINNOV consortium, stored at the 5G-LOGINNOV members storage systems and will be maintained until the end of the project.

Data processing and lawful basis for processing

The 5G-LOGINNOV consortium members will process your data, collected on the basis of consent, via the present questionnaire.

Voluntary Participation

The participation in this campaign is voluntary. You may choose not to take part or subsequently cease participation at any time.

Right to withdraw consent

You have the right to withdraw your consent at any time by emailing to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your contact details (i.e. name, email address), using as subject "Request to withdraw consent from the project". The data provided, up to the moment of withdrawal (of consent), can be used in the project. In case you wish to withdraw your consent, the data processing will be terminated. However, you cannot withdraw consent to processing that has already taken place.

Right to lodge a complaint

You have the right to lodge a complaint with the 5G-LOGINNOV Data Protection Officer Eusebiu Catana (e.catana@mail.ertico.com) without prejudice to any other administrative or judicial remedy, if you consider that the processing of your personal data infringes the provisions of GDPR regulation.

Right of access

You have the right to access your personal data and supplementary information (i.e. purposes of processing, the data types collected, etc.) at any time, by emailing to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your relevant request and contact details (i.e. name, email address) and, using as subject "Request to data access from the project".

Right to rectification

You have the right to obtain without undue delay the rectification of inaccurate personal data concerning yourself, by emailing to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your relevant request and contact details (i.e. name, email address) and, using as subject "Request to data rectification from the project".

Right to erasure

You have the right to request the deletion or removal of your personal data without undue delay, by emailing to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your relevant request and contact details (i.e. name, email address) and, using as subject "Request to data erasure from the project".

Right to restrict processing

You have the right to 'block' or suppress processing of your personal data, by emailing to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your relevant request and contact details (i.e. name, email address) and, using as subject "Request to data restrict processing from the project".

Right to data portability

You have the right to obtain and reuse your personal data for your own purposes across different services. In case you need a copy of your personal data, you have to email to the project coordinator Eusebiu Catana (e.catana@mail.ertico.com) your relevant request along with your contact details (i.e. name, email address), while using as subject "Request to data portability from the project". In such cases, we will provide you with your personal data in a structured, commonly used and machine-readable form, free of charge and within 1 month upon reception of your relevant request.

Do you accept the GDPR and Privacy terms and Conditions?

- Yes
- No

Section 15: End of the survey

In case you are willing to be contacted again by the 5G-LOGINNOV Consortium, please provide us with your contact details

Name and Surname

e-mail address

ANNEX 2: EXPLOITABLE RESULTS AT INDIVIDUAL PARTNERS' LEVEL - SUMMARY

Result ID (D5.5)	Updated Name	Result ID & Name in D5.4
ERTICO.1	Strengthening of the ERTICO Start-ups Initiative and the support of ERTICO's Transport and Logistics roadmap	ERTICO.1-Maximizing international visibility, attracting decision makers, expanding network of Start-Ups
AKKODIS.1	Updates of AKKODIS data collection tools	AKKA.1-Data handling and cyber security policies
		AKKA.2-Data collection architecture and tools
CIRCLE.1	Expansion of the Docks the Future Network of Excellence	CIRCLE.1-Awareness development and expansion of the Docks of the Future Network of Excellence
CONTI.1	Use of 5G telematics products in logistics sector	N/A
CONTI.2	Understanding of the outcome of the application of 5G Telematics products in various network conditions	CONTI.2-Results of exploitation of telematics products in various network conditions
ICCS.1	Acquisition of further expertise and know-how in the field of 5G, IoT and relevant ecosystem technologies in logistics and ports domain	ICCS.2-Acquisition of further expertise and know-how in the field of 5G, logistics and transport infrastructure
ICCS.2	Research and Development on Computer Vision Analytics Services	ICCS.3- Computer Vision Analytics Services, Research and Development
ICOOR.1	Customised GUEST Methodology	N/A
ININ.1	Improvements of Private 5G mobile system	N/A
ININ.2	Improvements of Industrial 5G IoT System	N/A
ININ.3	Improvements of Quality assurance services for 5G networks and cloud-infrastructure designed for ports and industry 4.0 environment	N/A
LK.1	Collaboration Model for implementing 5G-enabled technologies.	LK.1-Collaborations and Lessons Learned from 5G-LOGINNOV Consortium
PCT.1	Computer Vision Service for Daily Port Operations	PCT.2-5G-IoT Platform and Computer Vision Service Exploitation in Daily Port Operations
SWARCO.1	Standardised version of data format for traffic light forecast	SWARCO.1-Traffic light forecast as a data service for external applications like GLOSA

SWARCO.2	Mechanism to enable cities' traffic management to work with emission data originating from vehicles	SWARCO.2-Enable city traffic management to work with emission data originating from vehicles
TEC4U.1	Extension of the Entruck model	N/A
		N/A
		N/A
		N/A
TSLO.1	Improvements of Public 5G mobile network	N/A
TSLO.2	New business models for campus 5G networks	N/A
TSLO.3	Gaining further expertise in the field of 5G networks, logistics and transport industrial vertical	N/A
T-SYS.1	Upgraded version of the Low Carbon Mobility Management (LCMM)	
T-SYS.2	5G Cloud based IOT Gateway for Logistics Corridor Management and CO2 reduction	T-SYS.3-5G-IOT Gateway for Saving Fuel and Emissions Applying ISO-23795 LCMM
T-SYS.3	5G enabled City-Logistics and eXtended BRT for C-I.T.S. Emission Trading (CDM)	N/A
VICOM.1	Knowledge gain in AI/ML applied to logistics	N/A
VICOM.2	Seafront - Synthetic Dataset For Visual Container Inspection	N/A
VFI.1	Upgrade of the Vodafone Innovus IoT Platform with ML capabilities on 5G enabled edge devices,	VFI.1-Fleet Management Platform know how with 5G edge enabled devices

ANNEX 3: LIST OF INDIVIDUALLY GENERATED RESULTS

Result ID	Updated Name	Description	Application Area	Exploitation route
ERTICO.1	Strengthening of the ERTICO Start-ups Initiative and the support of ERTICO's Transport and Logistics roadmap	The Transport and Logistics roadmap will be impacted by project results.	Commercial	Developing and selling own products/services
AKKODIS.1	Updates of AKKODIS data collection tools	CTS: A Web-based application based on a 3-tier architecture for management of test data records (Centralized Testdata System – CTS) was developed in the AUTOPILOT project. In 5G-LOGINNOV this tool will be upgraded.	Industrial	Developing and selling own products/services
CIRCLE.1	Expansion of the Docks the Future Network of Excellence	Development of a specific section of the Docks the Future Network of Excellence web site (www.docksthefuture.eu) dedicated to both the submission of company profiles and applications by innovative technological providers and the publication of the strategic needs for innovative services by Ports and Logistics players (members of the Docks the Future Network of Excellence).	Commercial	Developing and selling own products/services
CONTI.1	Use of 5G telematics products in logistics sector	Use of 5G telematics products in logistics sector to optimise the driving patterns through the collection of real time data	Commercial	Developing and selling own products/services

CONTI.2	Understanding of the outcome of the application of 5G Telematics products in various network conditions	Findings and lessons learnt from the usage of CONTINENTAL's telematics products in various network conditions	Industrial	Developing and selling own products/services
ICCS.1	Acquisition of further expertise and know-how in the field of 5G, IoT and relevant ecosystem technologies in logistics and ports domain	Increased know-how in the design and implementation of the 5G-IoT platform including software and hardware components, and relevant ecosystem technologies	Research	Further Research
ICCS.2	Research and Development on Computer Vision Analytics Services	Know how in computer vision analytics/ML applications tailored (but not limited) to ports and logistics.	Research	Further Research
ICOOR.1	Customised GUEST Methodology	The GUEST methodology has been customised according to the development of innovative solutions, products, and services in the project LLs.	Research	Further Research
ININ.1	Improvements of Private 5G mobile system	Improved private 5G mobile system set up to suit specific needs of the ports/logistics domain	Commercial	Developing and selling own products/services
ININ.2	Improvements of Industrial 5G IoT System	Industrial grade 5G IoT System product improvements to suit specific needs of the ports/logistics domain	Commercial	Developing and selling own products/services
ININ.3	Improvements of Quality assurance services for 5G networks and cloud-infrastructure designed for ports and	Quality assurance services improvements to better suit specific needs of the ports/logistics domain	Commercial	Developing and selling own products/services

	industry 4.0 environment			
LK.1	Collaboration Model for implementing 5G-enabled technologies.	Partnership establishment with key industry stakeholders for the implementation and sustainability of solutions and further collaboration in future research/technical initiatives in Greece and beyond	Commercial	Collaboration Agreements
PCT.1	Computer Vision Service for Daily Port Operations	Implementation of a new service in the port area, based on Computer Vision	Industrial	Further Research
SWARCO.1	Standardised version of data format for traffic light forecast	The status of the traffic light and the prediction is made accessible to external applications thanks to this stardardised data format.	Industrial	Further Research
SWARCO.2	Mechanism to enable cities' traffic management to work with emission data originating from vehicles	Method to receive emission data from probe vehicles and combine it with other sensor data to derive a traffic management strategy	Industrial	Developing and selling own products/services
TEC4U.1	Extension of the Entruck model	The Entruck model is enriched with FTED and LCMM functions, and it is aliogned with ISO-23795 standards	Commercial	Developing and selling own products/services
TSLO.1	Improvements of Public 5G mobile network	Improved and tailored public 5G mobile network to address specific needs of the ports and logistic industry vertical.	Commercial	Developing and selling own products/services
TSLO.2	New business models for campus 5G networks	The Koper Living Labs will serve as reference business model ao investigate and shape the future of the vertical with 5G network technologies.	Commercial	Collaboration Agreements
TSLO.3	Gaining further expertise in	Know-how in designing and implementation of the 5G network and IoT	Industrial	Further Research

	the field of 5G networks, logistics and transport industrial vertical	with edge (MEC) capabilities for campus networks, such as ports and logistics		
T-SYS.1	Upgraded version of the Low Carbon Mobility Management (LCMM)	The LCMM is enriched with FTED and GLOSA functionalities and it is aliogned with ISO-23795 standards	Commercial	Developing and selling own products/services
T-SYS.2	5G Cloud based IOT Gateway for Logistics Corridor Management and CO2 reduction	TBD	Commercial	Developing and selling own products/services
T-SYS.3	5G enabled City-Logistics and eXtended BRT for C-I.T.S. Emission Trading (CDM)	TBD	Commercial	Developing and selling own products/services
VICOM.1	Knowledge gain in AI/ML applied to logistics	Know-how in computer vision analytics/ML applications tailored (but not limited) to ports and logistics	Research	Further Research
VICOM.2	Seafront - Synthetic Dataset For Visual Container Inspection	Synthetic datasets tailored for training deep-learning models designed for cargo-container inspection processes	Industrial	Further Research
VFI.1	Upgrade of the Vodafone Innovus IoT Platform with ML capabilities on 5G enabled edge devices,	Upgrade and implementation of the 5G-IoT platform including software and hardware components	Commercial	Developing and selling own products/services