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# ADMIRAL's Multimodal Digital Marketplace in the Logistics Industry: Addressing Corporate Sustainable Development Reporting Directive (CSRD)

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## Abstract

Indirect, external emissions, also known as Scope 3 industrial emissions, do not have to be reported by companies in the EU. Many companies currently only focus on their Scope 1 and Scope 2 emissions caused by their own energy consumption and ignore outsourced emissions. However, this will change with the new Revised Industrial Emissions Directive, which will require all companies operating in the EU to fulfil this reporting obligation by 2028. To achieve this, reliable and convenient tools are needed to measure, calculate, combine and report these emissions. To meet this challenge, the ADMIRAL project is developing a marketplace for logistics services. One of its key features is the ability to compile Scope 3 emissions data for multimodal logistics chains. By providing emissions data, the marketplace enables freight owners to make informed decisions about transport options. This in turn can help to reduce emissions. The marketplace brings together sellers and buyers of logistics services as well as developers and integrators of service solutions on a single platform. This ecosystem promotes the common goal of achieving a carbon-neutral world. This article discusses the legal framework in the European Union that obliges companies to report CO<sub>2</sub> emissions. It also presents the ADMIRAL project and its results in response to these regulations. In particular, it looks at the role of the ADMIRAL digital marketplace in meeting the legal requirements and facilitating compliance within the industry.

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*Keywords:* emissions, logistic marketplace, external emissions, delivery optimization, business models

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Carbon emissions have a significant impact on climate change and lead to various harmful environmental consequences. Therefore, measures should be taken to reduce carbon emissions and combat climate change in order to protect our environment and ensure the well-being of future generations (Sporkmann et al., 2023).

The transport industry is a major contributor to global energy consumption and is responsible for almost a third of total global greenhouse gas emissions (IEA, 2019). In the European Union (EU), the transport sector was also responsible for 33.9% of total energy consumption and 25.4% of total carbon dioxide (CO<sub>2</sub>) emissions in 2018

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(Tzeiranaki et al., 2023, Batur et al., 2019). Unfortunately, CO<sub>2</sub> emissions from road transport are rising due to the increasing use of passenger and commercial vehicles. As Neves et al. (2017) note, progress towards a low-carbon economy has been slower in this sector compared to other sectors.

The European Union has set itself the goal of becoming climate neutral by 2050 and reducing greenhouse gas emissions from cars by 55% and from vans by 50% by 2030 (EU, 2023). To achieve these goals, the EU has drafted various regulations, including the Corporate Sustainable Development Reporting Directive (CSRD 2022/2464/EU), which came into force in 2023. This regulation modernises and strengthens the rules around the social and environmental information that companies must report on. A broader group of large companies are now required to analyse the efficiency of their transport and logistics system and take the necessary measures to optimise the efficiency of their transport system. Global companies, especially those with supply chains that span the globe, have a critical role to play in reducing carbon emissions. They have the power to change the way logistics and supply chain organisations operate. They can lead the way by reporting their carbon emissions, setting climate targets and working with partners to achieve them. The new rules will apply to the first companies in the 2024 financial year for reports published in 2025 (CSRD, 2023).

The CSRD requires companies to consider emissions from all freight transport and hub operations, including transshipment points on a national and international basis (as shown in Fig. 1). This requires the company to calculate not only the emissions from its own operations and purchased energy (Scope 1 and 2), but also the emissions from subcontractor operations and the emissions generated during the transport of goods from suppliers to the reporting company and from the reporting company to the end consumer (Scope 3).

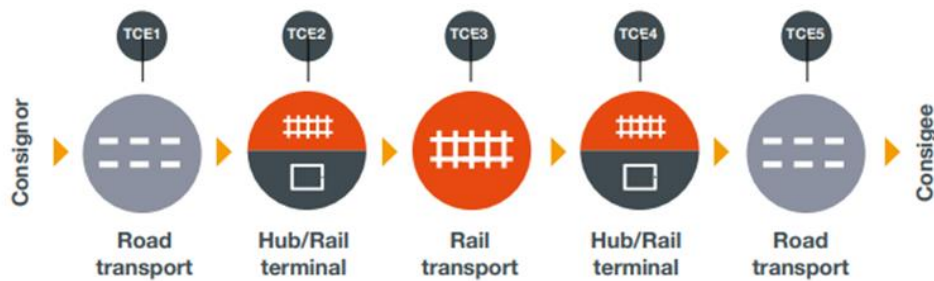


Fig. 1. An example of logistics chain operations considered in emissions calculations (Ehrler V. et al., 2023).

Scope 1 emissions refer to the direct emissions generated by the assets owned or controlled by the reporting company (Fig. 2). These include the fuels purchased to generate energy, heat or steam for use in stationary or mobile equipment such as vehicles, ships, aircraft, locomotives and generators, as well as buildings associated with logistics sites such as warehouses. Scope 2 emissions are indirect emissions resulting from the purchase of electricity, heat and steam by a company for use in its logistics sites, electric vehicles or other facilities that require electricity. Scope 3 emissions are also indirect emissions generated by the reporting company's supply chain. These include the transport emissions required to transport goods from suppliers to the reporting company, as well as emissions from the reporting company to the end customer. Scope 3 emissions are mostly caused by subcontractors (port operators, operators of various means of transport, owners of distribution centres, etc.) (GHG Protocol, 2013).

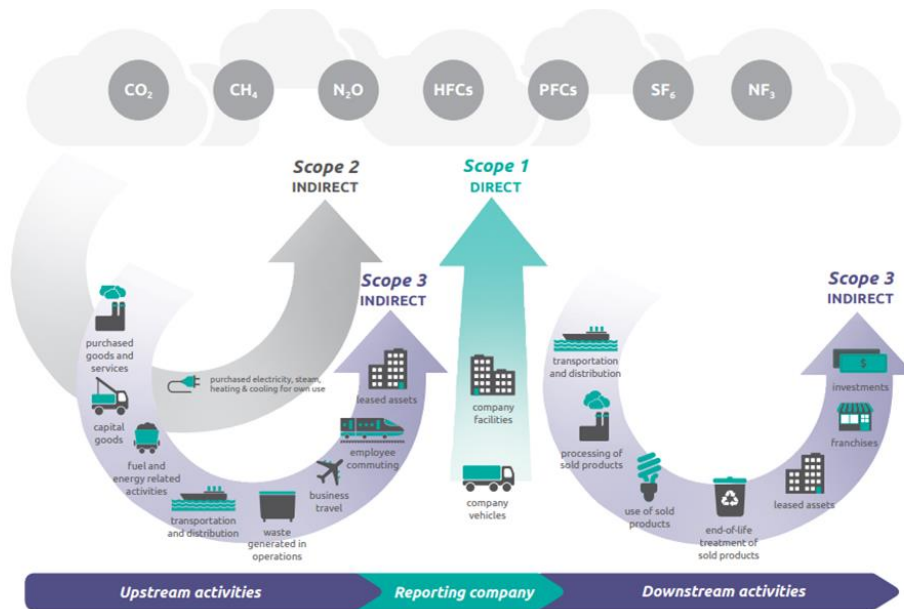


Fig 2. Presentation of scopes and emissions through the supply chain (GHG Protocol, 2013).

For large companies, reporting on their Scope 1 and Scope 2 emissions is generally not a challenge. However, reporting on Scope 3 emissions is a major challenge for various reasons, such as insufficient data collection and reporting, lack of clear communication, time-consuming sustainable development reporting, failure to set measurable targets, data overload, limited stakeholder engagement, insufficient supply chain insight and difficulties in obtaining high-quality data from cross-functional entities (iRISCARBON, 2023).

The ADMIRAL project solves a challenge related to Scope 3 emissions by designing a digital multimodal marketplace that enables forecasting emissions during the tendering phase, reporting actual or fairly accurate emissions after the transport has been carried out and selecting the greenest logistics provider. ADMIRAL marketplace will consist of applications that offer services and exchange information between users of the platform. It is expected that the marketplace will have two main types of users: Service providers such as different types of logistics service providers and buyers such as cargo owners, consignees and main contractors. The marketplace will help to facilitate collaboration between stakeholders, e.g., in ports and other logistics hubs. It will also include applications to improve certain port operations. In addition, the ADMIRAL marketplace will also act as an innovation platform for new services, as it will be developed in such a way that software and solution developers will have clear guidelines to include the invented services in the platform, which is a typical feature of innovation platforms. It will improve the value of logistics platforms, which is important in the global competition of B2B platforms. We recognise that business-to-customer platforms are dominated by non-European companies, such as Google, but the dominance among business-to-business platforms has yet to be determined. A significant potential impact lies in the marketplace's ability to include the entire supply chain between the manufacturer of goods and the buyer. For example, large shipping companies have solutions to estimate delivery times for their part of the supply chain, but do not estimate delivery times and emissions for the entire supply chain and may have limited co-operation with other shipping companies.

This paper provides background information on the implementation of a CSRD EU regulation and the challenges that companies face in this context. In addition, the paper presents a solution in the form of a multimodal digital marketplace that partially addresses the key challenge of Scope 3 emissions. It also shows who will develop this solution and how it will be developed.

### 1. Digital marketplaces in the logistics industry

The transport and logistics market shifted to a virtual environment several decades ago. In fact, Timocom was the first digital marketplace launched in 1997 as a platform for freight and vehicle exchanges (Timocom, 2024). Today, digital marketplaces connect numerous shippers/cargo owners, freight forwarders and logistics companies. The sellers of the services are the key component of these markets; the sellers bring their existing customer base to the marketplace and have the incentive to find new revenue streams (McFadyen, 2021).

There are many digital freight marketplaces around the world, most of which have emerged in the last decade and rely heavily on big data management and analytics. Most of them specialise in road transport and offer a wide range of services; however, some, such as Sea Rates, provide information on global transport services for all modes of transport.

On a marketplace, shippers can choose from a list of independent truck drivers (or other modes, depending on the marketplace) and logistics companies. In addition, they can specify what size of vehicle they need, or the offer is limited to the most suitable vehicles. Shippers can even plan the transport in advance or specify the desired delivery time.

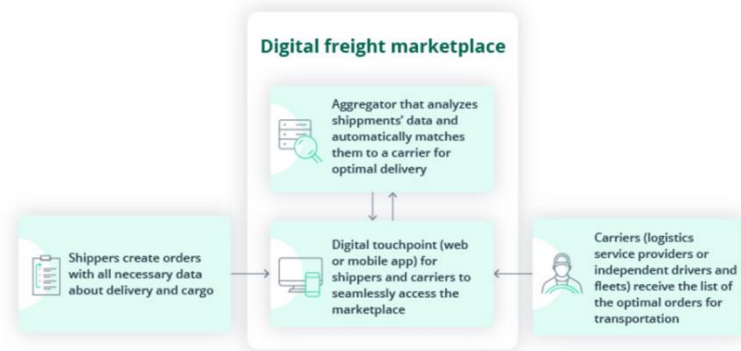


Fig 3. The functioning of a digital freight marketplace (Zavadko, 2023)

Digital marketplaces for transport and logistics are fast, efficient and easy to use. They provide a good basis for collaboration between different companies, automation and digitalisation, resulting in lower transaction costs, greater transparency of freight movements and reduced inefficiencies in transport and logistics processes (Lin, Mahmassani, Jaillet, & Walton, 2002). The use of digital marketplaces can achieve up to 10 % lower costs, 20 % better fuel efficiency, 30 % higher fleet utilisation and a 13 % reduction in empty runs (Trimble, 2024; Transporeon, n.d.). The following table shows the key features of two well-known and long-standing digital freight marketplaces: Timocom, Europe’s first digital freight marketplace, and Transporeon, which markets itself as the most comprehensive logistics network.

Table 1. Comparison between Timocom and Transporeon

	Timocom	Transporeon
Established	1997	2000
Offering	Freight and vehiclespace exchange, transport directory, calculation tools for route and transport costs; around 1 million freight and vehicle offer daily	Transportation management, freight procurement, and time slot management for docks and yards
Sellers	55,000 transport service providers 9,000 warehousing and logistics spaces across 46 European countries	1,400+ connected shippers, 158,000+ carriers, and 100+ retailers

Customers	More than 155,000 users, primarily from the European logistics sector	Predominantly from Europe, but also from Asia and Americas
Pricing policy	A variety of pricing plans	Free for shippers, EUR 100 per month for carriers
Revenues	EUR 90 million in 2022	EUR 190 million in 2023

Around 85% of truck traffic is contract freight, which is negotiated via annual tenders. On the other hand, digital marketplaces offer spot freight rates that fluctuate daily based on the real-time balance of supply and demand in the market. Factors such as route characteristics, commodity types, market conditions and timing (including lead time, day of the week, time of day and dwell time) influence spot rates (Transporeon, 2024). For example, customers can currently select the appropriate service based on parameters such as price, delivery time, range, etc. (Wezom, 2022), but not yet based on the environmental performance of the service offered. From 2025, all major European companies will have to record and report the emissions of all transport services offered or used. To help companies respond to the upcoming EU regulations, the ADMIRAL project aims to develop a multimodal marketplace for low-emission transport, which means that environmental criteria will be incorporated into the selection of transport services.

## 2. Evolution of the ADMIRAL marketplace: from conceptualization to implementation

The Advanced Multimodal Marketplace for Low Emission and Energy Transportation (ADMIRAL) project, coordinated by the VTT Technical Research Centre in Finland and co-founded by the European Climate, Infrastructure and Environment Executive Agency (CINEA), is a 36-month initiative starting in May 2023. It involves 20 beneficiaries and one affiliated entity in nine EU countries (see Fig. 4) and aims to enable better utilisation of existing assets and infrastructure to reduce emissions and enforce systemic change towards sustainability with sustainable procurement.

In addition, the ADMIRAL project aims to develop a marketplace based on four pilot projects: Portugal-Spain, Slovenia-Croatia, Lithuania and Finland, with a focus on energy and emissions reduction potential.

The created marketplace will also function as a software service platform, where clear guidelines and services can be found. The marketplace will improve the value of B2B logistics platforms and aims to reduce emissions by more than 20% and improve transparency and resilience.



Fig. 4. ADMIRAL marketplace concept.

### 2.1. Mapping the journey: work packages (WPs) and development phases for the ADMIRAL marketplace

The ADMIRAL project consists of seven work packages (Fig. 5), with WP 1 Management and WP 7 Communication associated with each work package. WP2 has the task of compiling background information on sustainability in logistics and WP3 to develop information on sustainable business models. WP4, WP5 and WP6 are closely linked as in WP4 pilots develop solutions that are tested in WP5 and in WP6 the pilots are evaluated to see their success. In the scheme, WP2 and WP3 play the role of information producers, but the results of WP4, WP5 and WP6 are also used here. The aim is to use all the material from the ADMIRAL project in the final results of these working groups and thus ensure the best possible outcome of the project.

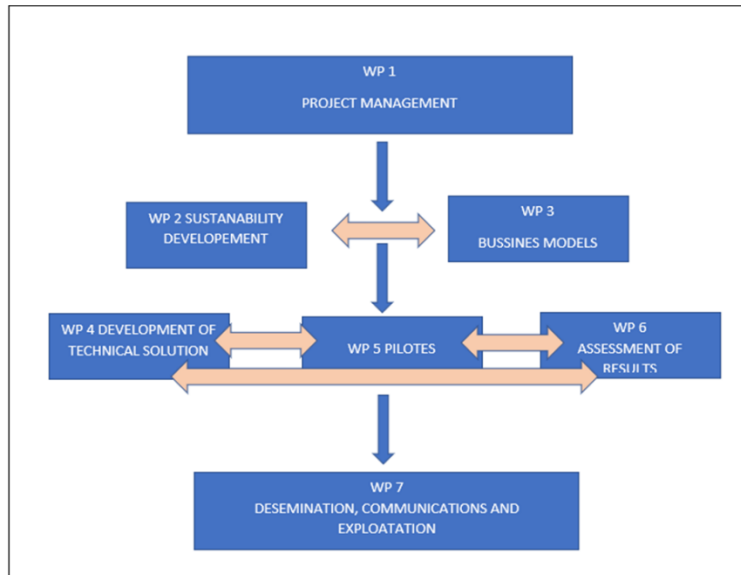


Fig. 5. ADMIRAL work packages

ADMIRAL WP2 has mainly the role of information developer and produces background information on the sustainable development of logistics and transport and addresses critical sustainability issues in the transport and logistics sector, such as low / zero emission logistics, reduction of fossil fuel energy consumption in transport and improvement of collaborative logistics. The work package is based on data mining techniques, a thorough literature review of scientific papers and surveys of global companies. It aims to identify the main transport modes and technologies, their expected impacts and their application to achieve sustainability goals in the pilot projects in Finland, Lithuania, Portugal-Spain and Slovenia-Croatia.

WP3 will focus on a thorough review of the vertical and horizontal business models that customers can use on the ADMIRAL marketplace. Particular attention will be paid to horizontal collaboration, as this presents more challenges such as legal restrictions and more potential barriers. The findings from this review will be used to modify or develop new business models in two steps: first by exploring existing models of potential customers of a marketplace and then by developing new models that enable buying and selling services on the ADMIRAL marketplace while being synchronized with its functionalities.

The aim of work package WP4 is to expand the marketplace for multimodal, emissions-conscious and optimised logistics and to extend AI-driven trading and routing to multiple logistics chains worldwide. The work package aims to build the partner community, the developer portal, the workflow tools for service fulfilment, the marketplace features, the AI capabilities needed on the marketplace, the industry-leading user experience for buying and selling logistics services and all necessary data integrations and APIs. The multimodal marketplace is based on the Awake.AI data platform, which makes it possible to effortlessly market data-intensive digital products in catalogues, complex services and their collaborative delivery, as well as everyday physical consumables all to be transacted with ease.

Work package five (WP5) refers to the pilot projects (Portugal – Spain, Slovenia – Croatia, Lithuania, Finland). This means that this work package coordinates the pilots and ensures the general conditions that can influence the establishment of the pilots. It is also related to WP3, where new collaborative business models in transport networks were designed, tested, monitored and analysed. Logistical data collection and processing is related to WP5. The tasks in this WP5 are divided into two phases. In the first phase, the solutions are tested as individual solutions. In the second phase, the developed solutions are then tested as part of the marketplace. The aim of each pilot project is to increase the visibility of emissions in the supply chain. These emissions become visible on the marketplace and influence the decision-making of buyers of services.

Work package 6 of the ADMIRAL project will assess the impact of the proposed pilot activities and the solutions offered in terms of energy consumption, transport efficiency, environment, user experience, stakeholder acceptance, socio-economic aspects and equity, transferability and overall impact assessment, taking into account real-life demonstration. This work package is extensive and divided into five tasks, which will be carried out by all but one of the project partners.

### **3. Pilot projects**

As part of the project, four pilot projects (a Portuguese-Spanish, a Slovenian-Croatian, a Lithuanian and a Finnish pilot project) will develop and demonstrate solutions to reduce environmental impact. Each pilot project will develop its own solution, which will later be offered on the marketplace. In Fig. 6 an overview of pilot project locations is shown.

The Portuguese-Spanish pilot project will develop a business case for the Sines-Madrid multimodal corridor, involving the Port of Sines, several logistics service providers, a rail operator, the dry ports and the authorities. to offer open and shared low-carbon/low-emission services to shippers. The creation of a multimodal and environmentally friendly digital corridor between Sines and Madrid for horizontal and vertical co-operation means a reduction in CO<sub>2</sub> emissions and energy from fossil fuels. This is beneficial for both the railway operator and the dry ports, as it implies the development of a digital integration of processes through the platform. This has a positive impact on synchronisation and collaboration, increased agility, digital coordination with the authorities and the reduction of administrative tasks.

The Slovenian-Croatian pilot project will optimise postal logistics between Slovenia and Croatia. The pilot project will bring together logistics networks, postal companies, freight forwarders and logistics service providers to optimise the transport route, shorten transport times and improve vehicle utilisation. This will also lead to a reduction in CO<sub>2</sub> emissions and energy consumption.

A pilot project in Lithuania aimed to create digital tools for interaction between the members of a logistics network to exchange data. As Lithuania has a high proportion of road transport, the pilot project will analyse data on truck freight delivery activities. This will help to identify the cooperation activities between the logistics network members where digital solutions could have the greatest impact, especially in terms of the added value of sustainability for customers and logistics network employees.

The Finnish pilot project will improve the efficiency of cargo flows at the Hietanen RoRo terminal, that is primarily intended for the export of forest products (paper, plywood, pulp, sawn timber), most of which is transported to the port by rail, although a large proportion of the cargo also arrives by truck. The aim of the pilot project is to develop AI-based tools that can improve the efficiency of forest industry freight flows through the port and optimise the use of labour, equipment and storage space. This will be possible through increased data exchange, digitalisation and AI-based planning.





Fig. 6. ADMIRAL project partners presentation (Pyykkö, 2023).

### 3.1. Evaluating the Performance of the ADMIRAL Marketplace in the Slovene-Croatian Pilot

The Slovenian Post (PS), the Croatian Post (HP), Solvesall (SOLV) and the University of Ljubljana, Faculty of Maritime Studies and Transport (UL) are participating in the Slovenia-Croatia pilot project. HP and PS are analysing the current business logistics framework between the Slovenian and Croatian Post, with a particular focus on existing planning tools, data structures/networks, processing, technology, legal frameworks and business logistics requirements. UL's role is to establish evaluation metrics (targets, key results and KPIs) that will help PS and HP to better understand the impact of the newly implemented solutions and technologies.

Postal logistics between the Slovenian and Croatian services involve large volumes of parcels. Postal logistics between the two operators (PS and HP) is handled via transshipment hubs, two logistics centres (Celje, Maribor) and two exchange offices (Ljubljana, Zagreb), and the parcel flow is facilitated by road transport on predefined routes and plans.

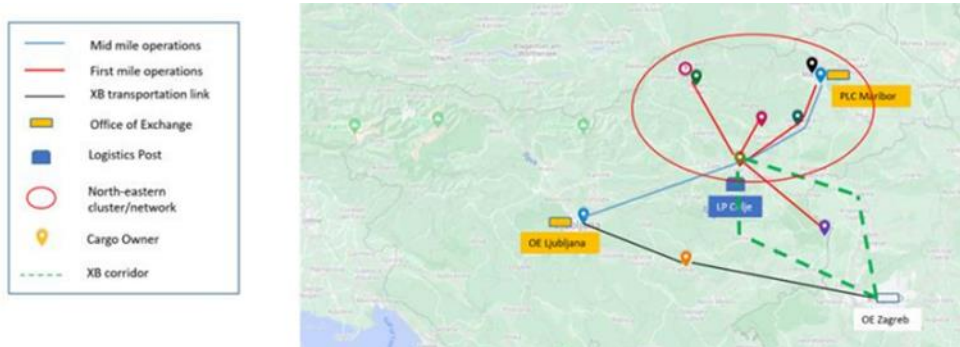


Fig 7. Scenario TO-BE delivery route between north-eastern parts of Slovenia and Zagreb (Croatia)

The partners involved in postal traffic from the north-eastern part of the Slovenian region to the Croatian region manage their own logistics network separately. Cargo owners from the north-eastern part of Slovenia represent about 40% of all the XB (Cross-border) cargo headed towards Croatia. The lack of integration between the logistics networks

of cargo owners and operators (PS, HP) leads to a disjointed information system. This leads to delayed information on shipment details such as quantity, weight and destination, which hinders proactive planning in the transshipment warehouses and transport execution. As a result, this leads to under-utilisation of cargo space, sub-optimal transport routes, delayed deliveries and impaired service quality for recipients. In addition, the use of the exchange office in Ljubljana for indirect shipments to Croatia causes unnecessary costs, including consolidation and transport costs, while at the same time exacerbating delivery delays and creating negative externalities. This problem of fluctuating demand for transport services and staff shortages attempts to smooth out peaks in demand. In this context, it is necessary to implement a marketplace platform together with the logistics planning tool. The end users of the marketplace services will have the opportunity to make their purchasing decisions based not only on price efficiency but also on sustainability efficiency. Transport service providers will be evaluated based on various sustainable criteria, such as cargo utilisation, energy efficiency, process route efficiency, low or no emissions and alternative fuel shipping vehicles. In summary, the objectives of the Slovenian-Croatian pilot project are to integrate, connect and harmonise the demand for logistics services and to streamline first-mile processes. Operational decision making is limited in the middle mile, while in the first and last mile there is a large scope for planning pick-ups and deliveries due to the lack of an optimisation tool for organising pick-up and delivery routes. Therefore, an AI-supported logistics planning tool was developed that focusses on the first and last mile in the Slovenian and Croatian pilot project. The tool will optimise pick-ups (first mile) by analysing shipment data and customer locations to determine the most efficient pick-up route. After consolidating shipments, the software will further optimise middle-mile delivery routes, facilitating the efficient transport of parcels to a specific facility in Zagreb. Particular attention will be paid to setting up ad hoc transport corridors to bypass the exchange office in Ljubljana and thus promote the integration of different logistics networks. At the point where the shipments arrive from Zagreb to the final consumers (last mile), they will be delivered by Locodels according to the optimised routes of the planning tool. In addition, the pilot seeks to implement an information structure that provides insights into the environmental footprint of business decisions within the respective logistics operations.

In relation to the tasks in WP5, both PS and HP are developing a comprehensive tool to connect isolated logistics networks. In line with this connectivity between the networks, SOLV will develop the logistics/transport planning tool to optimise the mid-mile and crowdsourced operations between Slovenia and Croatia. The logistics planning tool will be tested in simulated scenarios to obtain initial feedback on the performance of the platform, but also to deploy new solutions in a (controlled) test environment to capture the impact of the platform services on the ground. Performance and evaluation metrics, together with historical data, will help to determine the impact of multimodal digital platform services in the areas of CO<sub>2</sub> emissions, utilisation and cost optimisation. One of the main goals of the ADMIRAL project is to reduce emissions in the transport and logistics sector by more than 20% through process optimisation, but also to improve transparency and resilience. The Slovenia–Croatian pilot project aims to achieve the following main objectives:

- Increase the efficiency of XB mail processes between PS and HP,
  - Reduce the average kilometre performance by 25%
  - Reduce the average journey time by 20%
- Reduce emissions per parcel distribution by 25% and
- Increase the utilisation factor by 20%.
  - Increase shipment consolidation ratio through nearby logistics post by 50%.

The first step towards achieving these targets is to measure and evaluate the impact of emissions using the KPIs. In order to collect relevant data, measurements will be taken and analysed to compare the impact before and after the pilot implementation. In addition, the overall results will be monitored to assess efficiency and sustainability. UL will conduct measurements to thoroughly assess the impact of ADMIRAL solutions in the Slovenia–Croatian pilot by using the methodology and results of WP5 in terms of energy consumption, traffic efficiency, environment, user experience, stakeholder acceptance, socio-economic and equity, transferability, cross-analysis of pilot results and overall impact assessment considering real-life demonstrations (WP5). Furthermore, in WP6, together with other pilots, UL will support CTLup in building a framework for KPIs, data collection methods, a solution evaluation methodology and impact assessment methods. Based on this, CTLup will develop a framework and define performance indicators (PI) to assess the impact of the solutions on the logistics market.

The characterised and quantified PIs will be prioritised using an MCDA approach to define the needs of stakeholders and individual pilot sites. The assessed PI are compared with indicators measured at different pilot sites and with simulation modelling. In addition, the indicators are weighted for the levels of user-friendliness, availability, acceptance and resilience. Various data is collected before the pilot project is carried out (as part of WP5). Thereafter, data will be collected at monthly intervals during the implementation phases. Accordingly, UL will use the data collected during WP5 (including measurements) as an upfront reference before the pilot project implements solutions and thereafter. The process will be able to provide information in the form of a "development curve" to show how the solutions affect stakeholder acceptance and awareness. The results from each pilot site will be compared with each other to highlight the similarities between the different stakeholders in the EU (to find familiar approaches to ADMIRAL logistics solutions).

In order to determine the impact of the marketplace platform services in the areas of CO<sub>2</sub> emissions, utilisation and cost optimisation, UL will carry out measurements before and after the implementation of the solutions. As part of the network optimisation, several scenarios will be tested by integrating currently isolated logistics networks, i.e. postal operators (PS) and a crowdsourcing company, to better utilise the transport space of vehicles destined for the Croatian region, with the aim of 1. reduction of partially loaded means of transport for the Croatian region, 2. elimination of unnecessary trips and consolidation activities in the exchange office in Ljubljana through direct distribution from the post office in Celje to the exchange office hub in Zagreb, 3. optimisation of the transport route, 4. reduction of the time for transporting parcels to the Croatian hub. All these goals will lead to a reduction in CO<sub>2</sub> emissions and energy consumption, higher overall efficiency, shorter waiting times and improved delivery accuracy. For the measurements, UL will build a precise GNSS tracking device that will record the trajectories of the vehicles and be taken into the cabin by the drivers (Fig. 8). The device will automatically record the flight paths without the driver having to intervene. This measuring device records the geographical WGS-84 coordinates, altitude and GPS speed. These records are used to microscopically estimate vehicle emissions using the vehicle-specific performance model. Once the emissions per journey are known, it is possible to use the model for journeys before and after the pilot project and adjust the vehicle load to the reported values. In this way, the actual emissions are determined and the intended KPIs are calculated. With this method, the impact of emissions can be assessed more accurately than with average values per kilometre, as the method takes into account the impact of altitude differences and traffic conditions such as congestion and stop-and-go traffic on the routes.

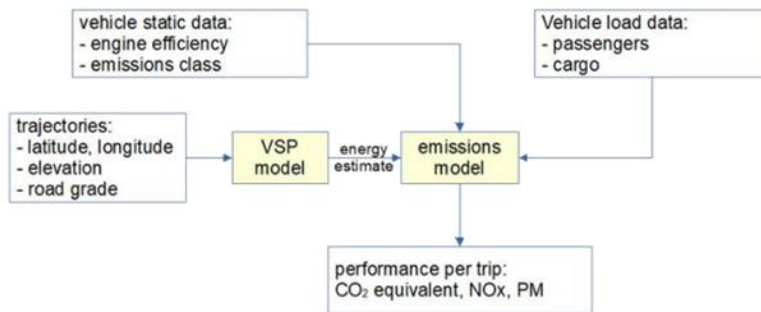


Fig 8: Emissions estimate using VSP.

#### 4. nario TO-BE delivery route between north-eastern parts of Slovenia and Zagreb (Croatia)

##### 4.1. Pilot project outcomes and expectations

The tool developed to optimise logistics planning will be integrated into the validated multimodal digital marketplace ADMIRAL for low-emission products. The CO<sub>2</sub> tracking system will also be integrated into the

marketplace to facilitate environmentally conscious decisions in the procurement of logistics services in the postal logistics chain. It is expected that emissions in the transport and logistics sector will be reduced by 20 % through process optimization. It will also improve stakeholder collaboration and supply chain resilience by providing a business model for a low-emission transport chain. The main benefits for the Slovenia–Croatia pilot project by achieving the defined targets can be described as follows

- Reduction of emissions: By optimising the transport network and logistical processes, this reduction contributes to environmental sustainability and helps to mitigate the impact of transport on climate change. In terms of emissions reduction per package distribution, the pilot project benefits from the calculation of emissions generated per package distribution (delivery).
- Increased efficiency: By reducing mileage, savings in fuel consumption and tyre wear are achieved, resulting in savings in operating costs and a lower environmental impact. Reducing journey time improves delivery speed and overall customer satisfaction.
- Increase the load factor: better utilisation of vehicles reduces the number of journeys required to deliver the same amount of parcels, resulting in cost savings and lower emissions. There are wider benefits for local residents too, as higher utilisation means fewer vehicles on the road, which can lead to a reduction in traffic congestion and associated emissions.
- Increasing the consolidation rate of consignments: Consolidating consignments allows for more efficient routing, avoiding unnecessary journeys and optimising delivery routes. Consolidating shipments from different sources avoids duplicate shipments, resulting in fewer empty or partially loaded vehicles on the road.

## 5. Conclusions

The ADMIRAL marketplace has enormous potential as it allows for the entire supply and logistics chain to work together without being limited to a specific activity or part of the chain. It is no longer necessary to use multiple platforms to provide supply chain services efficiently. In addition, the marketplace will promote new and innovative solutions that meet customer requirements. In addition, the marketplace will enable logistics and supply chain users and sellers to collaborate both vertically and horizontally, while promoting competition. This competition is not only based on price or other factors, but also on the emission values of the individual logistics service providers.

In order to operate a multimodal digital marketplace efficiently, modified or potentially new business models need to be developed for the platform owner and potential partners. These include truck companies, logistics companies, railway operators, ports, freight forwarders and developers of internet technology solutions. However, such business models are currently not available in the literature or in practise. The ADMIRAL project aims to uncover the (1) barriers that hinder the collaboration of partners and the utilisation of the marketplace functions and (2) identify enablers that promote collaboration. The results will feed into modified and new business models adapted to the ADMIRAL marketplace, but also useful for other logistics platforms.

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