# INNOVATIONS IN LOGISTICS

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**Authors:** Rutger Bijl, Nathan Jonker, and Sven Markus
**Design:** Michelle Haak - Miesart

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# 1 INTRODUCTION

**This paper is the result of a research conducted by three MSc students of the University of Groningen under the supervision of the program managers of TKI and professors from the University of Groningen, University of Twente, and Erasmus University Rotterdam. The goal of this research is to present an overview of innovative cross-company logistical applications related to the three priority themes from the research agenda of Topsector Logistics. These priority themes are 1. Supply Chain Coordination; 2. Sustainable Logistics; and 3. Data Driven Logistics.**

Data has been gathered by means of interviews with industry experts and researchers in combination with literature and web research. As there was a limited amount of time available for this research, the cases that are presented in this paper do not cover an exhaustive list of logistical innovations, rather, the researchers have opted to select cases that seem to contribute to the next steps within their priority theme. Based on the cases that have been investigated, per priority theme, sub-themes have been identified to be able to present the cases in a structured manner.

Besides the cases and the corresponding discussion which are described in the following chapters, the authors of this paper made some additional general observations, which may function as food for thought for the readers:

- The three priority themes cannot be seen independently from each other, the themes are interconnected and should be dealt with accordingly.
- Many innovative solutions that have been found in this research only fit fully digitized companies, as most (smaller) companies are not that far yet: what are their needs?
- The awareness of innovative projects or companies within Europe is rather low. Maybe a living database or platform could help in order to connect academics and companies in order to map and align the industrial and academic knowledge and needs.

# 2 SUPPLY CHAIN COORDINATION

Supply Chain Coordination (SCC) can be described as different forms of collaboration within or between supply chains that enable an efficient and effective organization of a logistical system of goods, money, and information. As we embrace the image of the *future of supply chain coordination* (Figure 1), the dot on the horizon of SCC is the concept of the Physical Internet (TKI Dinalog, 2021). This concept can be enabled by open, connected, and self-organizing logistics networks that are operated as a whole. In such networks, data is automatically shared and assets - such as load carriers - are enabled to make their own decisions. In self-organizing systems, goods opt for logical routes based on information on where the modes of transport are located and constantly adapt their own route or transport method taking into account road congestion, weather changes, or specific customer requirements (TNO, 2019). However, this system is not something that we can create tomorrow; this must be seen over time as the image illustrates (TKI Dinalog, 2021). Till then, we have to rely on the practices that are performed today. In this research, the current practices that have the potential to enable the future of SCC have been broadly divided into three sub-themes:

a. Supply Chain Visibility
b. Sharing and Matching
c. Digital Supply Ecosystems

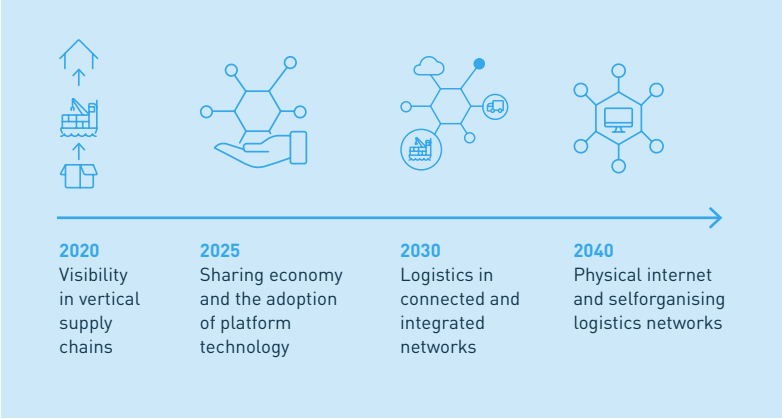


Figure 1. The future of supply chain coordination (TKI Dinalog, 2021)

## A. SUPPLY CHAIN VISIBILITY

Supply Chain Visibility (SCV) refers to the extent to which supply chain actors have access to timely and accurate information that is considered useful to their operations, such as the real-time location and status of assets (FourKites, 2021). Visibility is enabled by software that allows for digitization and automation of supply chain processes. The technology has existed in some form for decades, however, the latest generation of SCV tools are reaching maturity, and rates of adoption are growing throughout all industries. For decades, visibility was enabled by inefficient and retroactive check calls. Nowadays, companies use tools to track all sorts of telematics or sensor data from modes of transport, packaging, or load carriers. In this way, individual shipments can be tracked based on location, temperature, altitude, light, and shocks.

## PLATFORMS

Most of these insights are brought to you by visibility platforms. Visibility platforms are technology tools used by shippers, carriers, and other logistics providers in order to gather, interpret and analyze telematics information from a variety of sources presented on a single, actionable view (FourKites, 2021). Various visibility platforms exist. These platforms strive to provide their customers with end-to-end supply chain visibility on all modes of transport across all continents of the world. However, as indicated by some industry leading visibility platforms (Gartner, 2021), 100% visibility cannot be achieved by a single platform (Tive, 2021). Collaboration between multiple platforms might be a step closer to reaching 100% visibility as will be illustrated in the *Open Visibility Network* case.

**NAME**
Open Visibility Network

**YEAR**
2021-now

**COUNTRY**
Consortium of 6 US based companies (FourKites, Project44, Tive, Everstream Analytics, Cloudleaf, Transvoyant), and 1 UK based company (MarineTraffic), and still expanding.

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | To rapidly meet customers' current and future visibility needs, some technology providers have taken an integrated and collaborative approach called the Open Visibility Network (OVN). OVN is a network of visibility and analytics platforms and is still open to both visibility solution providers and end users. The network enables shippers, 3PLs, and carriers to expand visibility and data insights without adding more applications or switching platforms. The visibility providers can provide their mutual customers with an expanded set of visibility data in a single user interface with this infrastructure. This case has been selected based on its connected and *collaborative* nature. |
| **RESULTS** | Connecting shippers, carriers, and 3PLs through the OVN ecosystem results in actionable real-time insights that help stakeholders overcome challenges and proactively manage their customers' expectations. With the additional telematics and/or sensory data, more accurate ETAs can be broadcasted, and so, planning activities can be improved. With real-time visibility of shipments, the end customer can improve the delivery experience for internal or external customers and proactively save loads that are at risk of being late or rejected due to for example a temperature issue. |
| **CONDITIONS** | To benefit from the OVN, you must be a customer of one of the consortium partners. |
| **SOURCES** | https://www.openvisibility.com/<br>https://f.hubspotusercontent10.net/hubfs/2849111/Resources/White%20Papers%20PDFs/TIA-Whitepaper-Closing%20Gaps-20210610%20(2).pdf |

## INTELLIGENT LOAD CARRIERS

As visibility is not a goal in itself, visibility is an enabler of coordination and decision making. Leading SCV software solutions enhance their real-time freight tracking functionality with some or all of the following features: Predictive ETA calculations; Integrations with TMS and ERP systems for freight planning, tendering, and payment; Historical analytics and reporting; Appointment scheduling; and Proactive risk monitoring and recommendations. In this way, visibility allows for making informed decisions about disruptions and delays, identifying trends in lane, partner, or facility performance, and making improvements (FourKites, 2021). Mostly, visibility data is retrieved from telematics from modes of transport such as trucks, trains, ships, and planes. However, visibility can also be retrieved from smart packaging or load carriers such as pallets and containers. And if connected to a planning or replenishment system, these load carriers can make their own decisions, such as when to order. These early steps of *self-organization* will be further explained in the case of *Ahrma Pooling*.

**NAME**
Ahrma Pooling

**COUNTRY**
The Netherlands

**YEAR**
2014-now

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | Ahrma created a smart pallet with sensors to track location, shocks, humidity, and temperature which enables transparency in the supply chain. By connecting these individual pallets to the internet (IoT), valuable data is generated across supply chains. This data is captured in Ahrma's Big Data System which is made available for its customers. Examples of parties using the Ahrma pallets are large chemical concerns (BASF) and retailers (Unilever, Ben & Jerry's). Currently, the pallets are used in closed loop applications, however, sharing data and assets across supply chains might also be an interesting step towards open, connected, and self-organizing networks. |
| **RESULTS** | Visibility of used and unused pallets may result in better management and thus a reduction in the amount of (unused) pallets as the utilization degree can be improved. Additionally, alerts are created when certain parameters come above a certain threshold (e.g. temperature in cold chains). And so, product recalls can be allocated in minutes instead of weeks. Next to visibility, the pallets can be utilized for replenishing stocks at the production line: when the weight of stock on an Ahrma pallet goes below a certain threshold, new products can be automatically re-ordered. |
| **CONDITIONS** | Participating companies require a basic IT infrastructure for shipping documents and barcodes and require well organized processes in order to benefit the most from the intelligent pallets. |
| **SOURCES** | http://www.ahrmagroup.com/ |

## PRODUCTS AND CONDITIONS

Another form of visibility in the supply chain can be established by sharing production information and conditions in a network of multiple suppliers and procurers. This form of visibility enabled in a connected network will be discussed in the *Tradecloud one* case.

**NAME**
Tradecloud one

**COUNTRY**
The Netherlands

**YEAR**
2013-now

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | Tradecloud one created a trading platform for the manufacturing industry and wholesale which contains different networks in which supply chains and workflow can be organized. This platform is focused on supply chain optimization in order to make global supply chains more predictable based on transparency in products, order quantities, delivery times, prices, and discounts. By this, Tradecloud aims to automate operational procurement so that procurers and suppliers can focus on tactical and strategic trading activities. The network connects thousands of B2B procurers and suppliers who can collaborate in real-time on orders and confirmations, shipments, forecasts, item management, and invoices. With this platform, Tradecloud is one of the service providers of the SCSN data sharing standard. Participating procurers and suppliers on the Tradecloud platform are, for example. Eriks, Alfen, Damen, Nooteboom, Quooker and Gazelle. |
| **RESULTS** | The platform establishes less order administration: no more operational, manual purchasing handlings due to shared, digital catalogs (one version of the truth) and real time and in context communication between suppliers and procurers. In addition, SCV is enabled due to workflow automation and ERP/warehouse activities. Also, AI based order forecasts can be made for suppliers based on historical data to streamline the supply chain. |
| **CONDITIONS** | Applicable for larger industrial procurement and sales departments. |
| **SOURCES** | https://www.tradecloud1.com/nl/<br>https://smart-connected.nl/aangesloten-bedrijven/service-providers/tradecloud |

## B. SHARING AND MATCHING

### SHARING

A significant portion of collaboration and coordination within and between supply chains seems to be enabled by sharing and matching platforms. The sharing economy has been described as the societal shift from ownership to the sharing of goods, assets, or services by the use of digital platforms (DHL, 2021). What we currently see in logistics is that warehousing, personnel, and modes of transport are being shared in order to minimize excesses. As warehouse sharing is something that has been done for quite some time already, sharing modes of transport or even personnel seems to be rather new. In order to move towards open and connected networks, the concept of sharing may become inevitable.

## MATCHING

Another enabler of coordination and collaboration is the concept of matching platforms. In a matching platform, we see supply and demand being matched in order to reduce inefficiencies. These forms of collaboration can be unstructured (ad-hoc) or structured (contracted). For example, matchmaking can take place in an ad-hoc manner between a shipper and a carrier for a single shipment. On the other hand, some shippers may opt to only collaborate with their own pool of contracted carriers via a platform. Another form of matchmaking that is taking place in the field, is between procurement and sourcing with the aim to find the right suppliers to enable supply chain resilience. A step towards open, connected, and self-organizing networks can be taken by leveraging the network effects of existing platforms. For example by transforming platforms into logistical one-stop-shops and/or opening up the platform for non-customers as well, as the *Transporeon* case illustrates.

**NAME**
Transporeon

**COUNTRY**
Germany

**YEAR**
2000-now

**STAGE**
TRL 9: Global market deployment

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|---|---|
| **DESCRIPTION** | Transporeon offers a digital freight platform for supply chain collaboration with different modules. In its platforms, Transporeon offers strategic modules (such as market intelligence, tendering, sourcing and procurement) and operational modules (such as matching carriers and shippers, time slot management, visibility, and freight settlement). Offering all these modules in a single platform is unique in the market. Transporeon is mainly focused on road freight, but also covers intermodal: train, ocean, and some air. Transporeon intends to grow via collaborations with other supply chain solution providers and plans it as a solution open for non-Transporeon customers as well. |
| **RESULTS** | Supply Chain Visibility (by acquiring Sixfold, and collaborating with Roambee and Tive), freight audits and payments (by acquiring ControlPay), Real Time Yard Management (by collaborating with Peripass), Dynamic Time Slot Management (combining Time Slot Management with Real-Time Visibility information allows dynamic rebooking of time slots and provides a real-time view of yard activities), and spot buying optimization with AI leading pricing and decision-making. |
| **CONDITIONS** | As Transporeon is a facilitator in logistics collaboration and communication, using the execution module as a shipper operating with one carrier makes no sense. |
| **SOURCES** | https://www.transporeon.com/nl/<br>https://www.transporeon.com/en/about-us/news-and-events/article/transporeon-announces-new-partnership-with-roambee/ |

## C. DIGITAL SUPPLY ECOSYSTEMS

Digital Supply Ecosystems refer to structural digital forms of supply chain collaboration among or across supply chains in which the participating parties and their responsibilities are known and captured in the ecosystem. These forms of collaboration illustrate that platforms are not necessarily the way towards open, connected, and self-organizing networks. Existing platforms are expanded as the central orchestrator attracts new participants. As all participants have to conform to the way of working as the platform imposes, a monoculture may be created in which innovation is imposed top-down. In Digital Supply Ecosystems, multiple supply chain parties - even competing ones - collaborate in order to deliver the best possible service to their customers. By means of technical features, supply chain parties can share data and collaborate without losing their responsibility or data ownership. In this way, innovation is driven from the bottom-up and the variety in the ecosystem can be preserved as described in the *Vinturas* case.

**NAME**
Vinturas

**COUNTRY**
The Netherlands

**YEAR**
2019-now

**STAGE**
TRL 9: Continental market deployment

| | |
|---|---|
| **DESCRIPTION** | Vinturas is a decentral network of supply chain partners applied within the outbound logistics of finished vehicles (from OEM to final customer). By the use of Distributed Ledger Technology (encryption), this network enables supply chain collaboration between competing parties and stakeholders, without the need of sharing sensitive information as data can be decrypted on a need-to-know basis. The data ownership/ stewardship stays at the participants as there is no central owner or orchestrator of the data. This concept is applied in the automotive sector, but can also be leveraged in other supply chains. |
| **RESULTS** | Increased efficiency in the network due to real-time information sharing, quicker and trustworthy insights in case of a disruption such as damage to the vehicles. In addition, data on the DLT cannot be tampered with, which allows for an immutable data trail that tells you when which activity has taken place. Also, participants are dignified as there is no central orchestrator controlling the data. |
| **CONDITIONS** | Participating parties need to have digitized supply chains. |
| **SOURCES** | https://www.vinturas.com/about-vinturas/ |

# 3 SUSTAINABLE LOGISTICS

Sustainable Logistics refers to the series of measures adopted in order to reduce environmental impact and improve profitability in the long-term. The dot on the horizon is a zero-emission and competitive logistics sector. In the shorter term, the objective of the Dutch logistics sector is to reduce $CO_2$-emission by approximately 30% in 2030. Numerous policies and incentive systems are introduced to stimulate the transition to clean(er) energy sources and vehicles, such as the creation of zero-emission zones in several cities. Yet, the challenge remains immense and close collaboration between companies and support of public agencies is required to meet the objectives.

There exists no clear roadmap for Sustainable Logistics. There is also not one single way to reduce or even eliminate emissions in the logistics sector, but a number of different approaches. Generally, in order to achieve Sustainable Logistics, measures can be taken that relate to (1) more efficient logistics in order to reduce emissions and waste, (2) and avoiding emissions by using zero-emission strategies. To take adequate measures, accurate insights into current operational data, such as emissions, is required. Therefore, taking into account the three focus areas of TKI, the following framework was developed in order to be able to categorize innovations and provide a tool to support the development of a research agenda.

| | SUPPLY CHAIN | NODES & CORRIDORS | CITIES |
|---|---|---|---|
| **REPORT** | • Carbon Footprint<br>• Other Externalities | • Carbon Footprint<br>• Other Externalities | • Carbon Footprint<br>• Other Externalities |
| **REDUCE** | • Circular Economy<br>• Sustainable Energy<br>• Supply Management | • Synchromodality<br>• Collaborative Platforms<br>• New Transport Solutions | • Last-Mile Solutions<br>• Collaborative Platforms |
| **AVOID** | • Supply Management<br>• Zero-Emission Energy<br>• Cradle-to-Cradle | • Zero-Emission Logistics<br>• Renewable Energy Infrastructure | • Zero-Emission Logistics<br>• Renewable Energy Infrastructure |

Figure 2. Sustainable logistics framework

Although not explicitly incorporated in this framework, customer behavior is an important factor to take into account too. It was found that the adoption rate of nudging strategies among Dutch companies is not very high, while scientific research has shown potential of influencing customer preferences by environmental incentives (e.g. Fu & Saito, 2018).

## A. REPORT

*Report* refers to organizations being able to understand and better manage their environmental impacts. Reporting allows organizations to identify risks and improvement opportunities, while tracking performance over time.

Currently, several emission reporting tools exist and some are widely adopted by logistics companies. Several emission reporting tools have been accredited by the Smart Freight Centre, and TKI has been involved in developing a reporting tool (i.e. BigMile) too. Most, if not all, of these initiatives, however, rely on estimates that are provided by the GLEC framework. The case highlighted for this sub theme is one of the first to incorporate real-time data to provide facts on emissions. This allows to brainstorm on the opportunities this provides, for example for tracking emissions in specific areas such as cities.

**NAME**
Key Environmental Indicators (KEI) - Transporeon

**COUNTRY**
Germany

**YEAR**
2021-now

**STAGE**
TRL 6-7: Demonstration

| | |
|---|---|
| **DESCRIPTION** | Tool that provides options for automatic GHG calculations, reporting, benchmarking, offsetting and reducing based on 25+ million annual transports. Transporeon collaborates with EcoTransIT, the most funded and accredited emissions calculator tool in the market, and extends its solution by integrating real-time data into the calculations derived from telematics systems to provide facts and not mere estimations. It provides a standardized dashboard with information on actual GHG emissions from fuel consumption to visualize and track emission reduction on shipper and carrier level (synchromodal). Currently, the focus is on trucks, as Transporeon already has telematics integrations, but other transport modes will be integrated in early 2022. The Emission Management System is based on the GLEC framework and a scientifically validated methodology, which will be publicly audited by the Smart Freight Centre. |
| **RESULTS** | With the infusion of extensive and rich real-time data, companies (shippers and carriers) are able to manage (i.e. measure, compare, reduce and report) their emissions across all supply chain flows. The real-time data allows to take out all estimation buffers and provide facts on emissions and corresponding data (e.g. emitted, location, etc.). Additionally, incentives can be developed to stimulate zero-emission operations and sourcing. |
| **CONDITIONS** | In order to provide real-time data, integration with (advanced) telematics is required. Currently, 20% of the telematics provide the actual fuel consumption. The golden source of information is fuel consumption, but no clear method exists to identify what fuel was actually consumed. |
| **SOURCES** | https://www.youtube.com/watch?v=ipIUF0vPENo&ab_channel=Transporeon |

## B. REDUCE

*Reduce* refers to strategies adopted to reduce emissions, either by increasing efficiency or by opting for the greener alternative.

At a Supply Chain level, sustainable energy is slowly but surely integrated more into business operations and many initiatives exist to reduce emissions through responsible sourcing (e.g. see TKI report on Supplier Sustainability Improvement, or Scoutbee.com). Yet, despite that many initiatives can be found on a business or product level, projects revolving around creating a circular economy at this level are rather scarce. Projects such as SHAREBOX, which focused on sharing by-products and resources, have shown significantly positive results but wide adoption is lacking. It seems there is a need for tools to provide visibility and trust. The *Circularise* case aims to contribute to this in order to enable circularity in the supply chain.

**NAME**
Circularise

**COUNTRY**
The Netherlands

**YEAR**
2016-now

**STAGE**
TRL 9: Continental market deployment

| | |
|---|---|
| **DESCRIPTION** | Circularise offers a web-based product tracking system, which can be applied in a virtual and endless range of product value chains. More specifically, Circularise provides a blockchain-based platform where each stakeholder involved in a circular value chain can share and use material information while maintaining privacy over sensitive data. The platform allows for responsible sourcing and effective recycling practices by creating a tamper-proof audit trail for (raw) materials, enabling material traceability, tracking environmental indicators and other sustainability metrics (such as compliance with SDG). |
| **RESULTS** | A more focused recycling approach for organizations, a higher quantity and quality of secondary raw materials and securing sources of raw materials. Additionally, the platform can be coupled with incentive systems (e.g. tokenization). |
| **CONDITIONS** | Its patent-pending technology called "Smart Questioning" allows stakeholders to retrieve information from databases where information on the product is stored. Therefore, it is dependent on a certain level of digitization and reliable input (i.e. the classical 'garbage-in-garbage-out-problem'). |
| **SOURCES** | https://www.circularise.com/<br>https://www.duurzaam-ondernemen.nl/circularise-brings-the-most-secure-blockchain-solution-for-transparency-across-plastics-supply-chains-to-ces-2021/ |

At the level of Nodes & Corridors, Topsector Logistics' Lean & Green program is heavily involved in synchromodality projects and several companies, such as NextLogic, Contargo and TEUbooker, exist to promote synchromodality. In the chapter on Supply Chain Coordination, platforms to share resources are extensively discussed.

Additionally, very interesting developments, which can be related to New Transport Solutions, are taking place that can potentially disrupt the transportation sector. Two projects that are currently in the demonstration phase are highlighted.

**NAME**
Zero Emission Services (founded by Engie, ING, Wärtsilä and Port of Rotterdam Authority)

**COUNTRY**
The Netherlands

**YEAR**
2020-now

**STAGE**
TRL 7: Market demonstration

| | |
|---|---|
| **DESCRIPTION** | ZES launched the first all-electric inland vessel, using interchangeable containers for propulsion which are charged with green electricity. It aims to develop an open-access charging infrastructure to create Green Energy Hubs and uses a pay-per-use payment system. The ZESpacks (with enough energy capacity to charge 36 electric cars) can be used to supply and store energy at all kinds of locations and can perform grid operations. The company's infrastructure is designed to be flexible and scalable. |
| **RESULTS** | It is estimated that a 1.000t CO2 and 7t NOx reduction per ship per year can be achieved.<br>Heineken partnered up with ZESPacks by means of a 10-year contract and it currently uses the first all-electric inland ship (the Alphenaar) on the corridor Alphen aan den Rijn – Moerdijk. The Alphenaar is sailing with two ZESpacks, which can be loaded and exchanged at the first charging station in Alphen aan de Rijn. |
| **CONDITIONS** | Currently, it is not economically viable without government support compared to existing diesel-solutions. But: a new EU-Project called 'Current Direct' (with almost 12M budget) aims to cut the cost of today's marine battery electric vessels in half. It will also create an EaaS platform that will stimulate the shift to clean energy in shipping and create new business opportunities. |
| **SOURCES** | https://zeroemissionservices.nl/en/homepage/<br>https://www.currentdirect.eu/<br>https://www.eba250.com/marine-electrification-current-direct-project-seeks-to-halve-marine-battery-electric-drivetrains-costs/?cn-reloaded=1 |

**NAME**
Zero-Emission Trucks

**COUNTRY**
Germany & Sweden, Switzerland

**YEAR**
2021-now

**STAGE**
TRL 7: Market demonstration

**DESCRIPTION**

Siemens is currently conducting pilots in Sweden and Germany with its eHighway system, which could enable unlimited operational range within the infrastructure. The Overhead Contact Line (OCL) supplies electric (or hybrid) trucks with power via an active pantograph, capable of connecting while driving at any highway speed.

H2 Energy & Hyundai have been testing their Xcient Fuel Cells extensively in Switzerland: more than 1 million km driven by 46 trucks in 11 months. 140 units of the newest heavy-duty truck will be shipped to Switzerland at the end of this year for pilots. Operators participating in the pilots are charged based on a pay-per-use system.

**RESULTS**

First results indicate that if 2% of total Germans roads are supplied with an eHighway system, more than 60% reduction in emissions can be achieved. Also, no/less need for massive investments in other charging infrastructure.

Pilots are successful and users have praised FC Trucks for its climate friendliness, short charging times and large driving range.

**CONDITIONS**

Greatest hurdle to a large-scale rollout seems to be the initial infrastructure investments. Costs are estimated to be 2.5M per kilometer, Yet, a recent study in the UK concluded that the investments can pay for themselves within 15 years.

Adequate charging infrastructure must be in place to make the use of FC Trucks feasible for long distances.

**SOURCES**

https://www.itsinternational.com/its9/news/consortium-study-uk-ehighway-feasibility
https://www.itsinternational.com/its9/news/consortium-study-uk-ehighway-feasibility
https://www.ttm.nl/trucks/hyundai/hyundai-rijdt-al-1-miljoen-km-met-xcient-fuel-cell/138578/

As new regulation is strongly focused on Cities, it is important to develop future-proof strategies. Currently, many startups are working on disrupting the last-mile logistics by testing futuristic solutions, such as drones and droids, and are receiving extensive funding. Alternatively, cargo bikes have already proven their worth in many cities and adoption rates are increasing. Yet, no one solution stands on its own. More specifically, in order to make last-mile logistics sustainable, several measures have to be taken that together can realize the objective. Therefore, one case will be highlighted that incorporated many valuable lessons from similar (failed) projects and indicates the need and potential of integrating several solutions.

**NAME**
Collaborative Urban Logistics and Transportation (CULT) initiated by Tri-Vizor, currently backed by seven large companies

**COUNTRY**
Belgium

**YEAR**
2021-now

**STAGE**
TRL 8: Preparation for market deployment

| | |
|---|---|
| **DESCRIPTION** | Independent initiative for smart consolidation of volume for companies of the 'CULT community' on the outskirts of the city of Antwerp. CULT is aiming for what it calls a 'Green Deal Delivery', with delivery at fixed times, using green means of transport, such as cargo bicycles and electric delivery vans, and with couriers who work under responsible working conditions. Once successful, CULT intends to roll out smart urban distribution to other cities as well. In the Netherlands, PostNL initiated Stadslogistiek NL (successor of SimplyMile) to realize city consolidation centers for warehousing, fulfilment and cross docking by working together with local hubs in several cities. |
| **RESULTS** | By smart consolidation and shared last-mile delivery, quality of life in cities can be positively impacted and (cost) efficiencies can be gained. Especially if combined with other last-mile solutions, such as the use of multi-brand (i.e. provider-neutral) parcel lockers and Micro-Depots at strategic locations (as in Hamburg, for example), which also allows for night-time delivery. The KoMoDo city hub project in Berlin has already shown positive results for the combination of hubs with cargo bikes, and other case studies found very beneficial results in the usage of parcel lockers in terms of sustainability and cost-efficiency (e.g. Van Duin, et al., 2020). |
| **CONDITIONS** | Many hub-concepts have already been tested. While several showed significant positive results in terms of sustainability (e.g. case study of HvA and UvA), developing an interesting value proposition and governance structure remained challenging, leading to bankruptcy of several initiatives (e.g. SimplyMile and Eelde). Volume and collaboration were found to be key ingredients of a successful formula. Currently, CULT is receiving substantive and financial support from the city of Antwerp. |
| **SOURCES** | https://www.cultcitylogistics.be/<br>https://smartcity.db.de/en/<br>https://www.velove.se/news/komodo-city-hub-project-in-berlin-it-works-its-fun /<br>van Duin, J. R., et al (2020). From home delivery to parcel lockers: A case study in Amsterdam. *Transportation Research Procedia*, 46, 37-44. |

## C. AVOID

*Avoid* refers to completely eliminating emissions by using zero-emission strategies.

At the Supply Chain level, this entails incorporating zero-emission energy throughout the entire value chain and developing a closed circular economy. No projects were found that could be included in this report as showcases. However, related to Nodes & Corridors and Cities, many projects associated with zero-emission vehicles exist and the adoption rate of these vehicles is increasing. Crucial for success is adequate infrastructure, which is currently experienced as one of the bottlenecks for further adoption of zero-emission transport. Therefore, two projects related to the development and use of renewable energy infrastructure will be highlighted.

**NAME**
Bidirectional and Smart Charging Systems

**COUNTRY**
The Netherlands, UK

**YEAR**
2017-now

**STAGE**
TRL 7: Market demonstration

| | |
|---|---|
| **DESCRIPTION** | Through the mySMARTLife project, Finland was the first country to install a public, bidirectional electric vehicle charging point, complemented with solar PV energy installation and a stationary energy storage system, in late 2017. Currently, Hyundai and We Drive Solar are testing bidirectional charging at charging stations throughout Utrecht and are integrating the car sharing system of We Drive Solar to upscale to 150 bidirectional shared cars in early 2022.<br><br>Menzies Distribution operates the largest electric fleet and commercial charging infrastructure in the UK and has implemented V2G and Smart Charging solutions. Its depot in Bow (London) is home to 80 smart inter-connected chargers making it not reliant on public infrastructure. |
| **RESULTS** | Smart Charging and V2G operations will support a stable grid and can increase load capacity to provide a stronger renewable energy infrastructure. Utrecht already has more than 500 bidirectional charging systems in operation, and Menzies Distribution has set an industry example. |
| **CONDITIONS** | For electric vehicles to function as a virtual power plant, aggregation is one of the biggest challenges. The fleet-to-grid solution as shown by Menzies Distribution might help to overcome this barrier and can be scaled up to other companies and supply chains. |
| **SOURCES** | https://www.electrive.com/2021/09/16/sono-motors-sion-solar-car-to-join-large-scale-v2g-project-in-utrecht/<br>https://www.companynewshq.com/company-news/logistics-company-news/menzies-distribution-awarded-most-innovative-company-of-the-year-at-the-logistics-uk-2020-awards/ |

# 4 DATA DRIVEN LOGISTICS

Data driven logistics (DDL) refers to the use of data driven technologies in the supply chain and the accompanying logistics. The ultimate dot on the horizon for this theme is a system of self-organization where necessary data is shared automatically and assets make decisions by themselves and where the role of companies within the supply chain is truly changing. This indicates a paradigm shift regarding this theme. The old perspective of data silos is changing to an end-to-end data integration. Ultimately this has as a consequence that the responsibility for the technology or cooperation is self-organized. This self-organization results thus in the responsibility not being carried by a specific entity and is shared among the partners of the supply chain or specific cooperation.

In the logistics industry, most (SME) businesses are still focused on the cleaning and generation of data, which happens before data integration and analysis. Data driven logistics has legacy problems that are the root cause for this phenomenon. The worldwide DDL landscape gets immersed by great start-ups that do prospective things with data driven logistics. This transition of future-oriented data use will be advanced by these refreshing technology-driven platforms, initiatives and companies. In the Dutch logistics landscape, the lack of standardization and data sharing hinders this advancement. The challenges discussed in this research are not only technical in nature but also include for example cybersecurity, human interaction, and business models.

The arrangement of data driven logistics is necessary for the other two themes of Supply Chain Coordination and Sustainable Logistics. It is a precondition for a successful transition to a zero-emission and competitive logistics system. Data driven logistics is pretended to be all aspects related to data driven logistics apart from the elements that are covered by Supply Chain Coordination and Sustainable Logistics or have coordination or sustainability as a goal.

Different topologies are possible regarding this theme. In this research, the practices related to DDL have been broadly divided into four sub-themes:

a. Cybersecurity
b. Data sharing
c. Human interaction
d. Business models

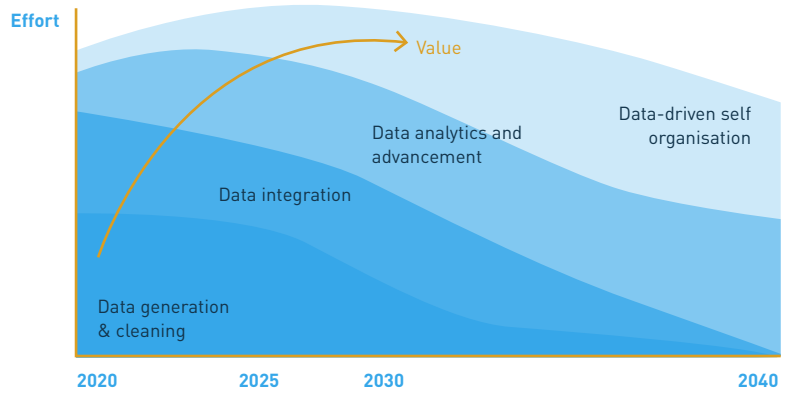


Figure 3. Advanced Data Use as the future of data driven logistics (TKI Dinalog, 2021)

## A. CYBERSECURITY

Cybersecurity is crucial for DDL and for the advancement of the self-organizing system. It is a precondition and must not be underestimated. Cyberattacks have targeted a lot of logistic companies such as container majors A.P. Moller – Maersk, COSCO, Mediterranean Shipping Co., and CMA CGM. The estimated loss for example for A.P. Moller – Maersk in 2017 is estimated at $300 million (Peters, 2021). Various reports have confirmed that the awareness of cybersecurity in the logistics industry is very low. For example, in a survey it was found that 55% of logistic employees feel they are ill-equipped to identify or handle a significant cyberattack (Prabhughate, 2020). It is clear that the consequences of ill-managed cybersecurity are severe. The logistics industry is especially sensitive to these attacks due to the high network integration that hopefully delivers value in the future. The pandemic of COVID-19 increased the cyberattacks extremely, for example the attacks on IoT networks went up 833% from June 2019 to June 2020 (Díaz, 2020). There is a gap in the approach and resources that large corporations (can) dedicate to cybersecurity compared to smaller enterprises. But it is sure that the logistics industry does not pay enough attention to this important theme (Poulus et al., 2020). Cybersecurity is at this moment a topic that seems to stand far away from the logistics sector itself, but due to the high network integration and severe growing consequences deserves urgent attention.

Existing projects that primarily focus on cybersecurity in logistics are limited. It is assumable that confidentiality plays a major role here. Companies such as Cipher, Nozomi networks, and Tesorion are companies that proactively profile themselves with cybersecurity specifically in the logistic sector, but the number of companies is limited. *Cyber-Mar* is a unique project that tries to stress the importance and deliver tools for cybersecurity and cyber range.

**NAME**
Cyber-MAR

**COUNTRY**
European Union

**YEAR**
2019-2022

**STAGE**
TRL 7: Market demonstration

| | |
|---|---|
| **DESCRIPTION** | Large EU-funded project that aims to develop an innovative cybersecurity simulation environment in the maritime sector. It aims to fully unlock the value of the use of cyber range (simulation environments) in the maritime logistics value chain, which can be transferred to other industries as well. This is done by a knowledge-based platform and a decision support tool for cybersecurity measures. The project cooperates under the Cyber-Range network with SPIDER and FORESIGHT, two other cyber range projects.<br><br>The deliverable is a decision support tool for cybersecurity measures, deployed by novel risk analysis and econometric models. But most importantly the project delivers training programs to increase the awareness and knowledge level. |
| **RESULTS** | The project has completed a virtual pilot scenario at the port of Valencia with a cyber-attack scenario on the port authority's electrical grid. The project will perform additional pilot scenarios focused on 1. vessel navigation and automation systems and 2. a SCADA system in a container terminal. |
| **CONDITIONS** | - |
| **SOURCES** | https://www.cyber-mar.eu/ https://www.cyber-mar.eu/event/cyber-mar-valencia-pilot-event-material-access/ |

## B. DATA SHARING

Data sharing is essential for DDL as this empowers the full exploitation of advanced data use and is a step towards a system of self-organization. As data sharing in itself is to some extent discussed in chapter 2, this chapter will focus more on the conditions that are needed to enable data sharing in the logistics supply chain. The problem to set up data sharing involves problems related to governance and scalability (TKI Dinalog, 2020). To enable data sharing standardization, public-private exchange and cleaning & generation are considered. Data driven planning and mobility integration are the other two sub-themes within data sharing: these highlight the substantial evolution of data sharing within DDL.

## STANDARDS

Standardization is crucial for effective data sharing. In Europe, there are several initiatives about standardization such as Gaia-X, Fenix Network and FEDeRATED. On a national level iShare, Data Logistics for Logistics Data, and DEFLog can be identified. TKI Dinalog is actively involved in the majority of those projects. The technology for most data sharing standards has been developed but the adoption is moderate. Furthermore, it remains the delicate question of whether this standardization will happen cross-sectoral or not. An inspiring example is *ONE Record* of the International Air Transport Association (IATA), which has a high adoption for their electronic Air Way Bill and is now actively developing standardization regarding IoT applications in air freight.

**NAME**
ONE Record (IATA)

**COUNTRY**
World-wide

**YEAR**
2017 - now

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | This e-freight program has set the foundation for the digitalization of the air cargo industry. ONE Record is the standard for data sharing and creates a single record view of the shipment. This standard defines a common data model for the data that is shared via standardized and secured web API. The most important project started called 'interactive cargo' will test the ONE Record data model for IoT applications in air freight with multiple pilots. A pilot to highlight is the pilot of Vedia (Finland, corridors as a service) that is seeking ONE Record for air-road transport and especially focusing on IoT aspects and data sharing in multimodal logistics chains integrated in border crossing. |
| **RESULTS** | The e-AWB (also from IATA) is now used for more than two out of three shipments for air freight. The project has ten use cases and 49 pilot companies, including large airline companies. The standard is used in living labs of FEDeRATED (EU project on data interoperability of platforms). |
| **CONDITIONS** | Participating parties need to have digitized supply chains. |
| **SOURCES** | https://www.iata.org/one-record/ |

## PUBLIC-PRIVATE EXCHANGE

Related to the standardization in data sharing is also the public-private exchange of data. This is a special matter which for example considers digital customs. It has been observed that integration of this public-private interaction in platforms is increasing. For example, companies that ensure route planning or logistics optimization also include customs and regulatory compliance as a feature. To assist this process, decent adoption of data sharing standards can help. Regulations that enforce the use of standards, such as electronic Freight Transport Information (eFTI), can assist in harmonizing data exchange (International Road Transport Union, 2020).

## CLEANING AND GENERATION

Cleaning and generation is the first precondition for effective data sharing. As mentioned earlier, legacy problems hinder data use and advancement in logistic companies. There are not many specific projects on the first step of data advancement, which is especially crucial for smaller companies. One example that went in that direction is the DiSCwise project of the European Union, finished in 2012, that focused on helping SMEs to profit from global digital supply chains. Another example is the Autonomous Logistics Miners project of TKI where the use of smart data mining agents in logistic processes was researched, professionals were helped to make data driven decisions and routine tasks were automated. This project also focused on SMEs. Cleaning and generation of data seems to be most relevant in the upcoming ten to fifteen years, as thereafter it might be expected that this is adequately managed in most processes and companies. Upcoming platforms will also accelerate this process. Companies that cannot adapt to this data advancement in a decent way, because the cleaning and generation are not in order, have the risk of being outcompeted by data-advancing companies. Data generation specifically has a lot of overlap with projects that ensure data visibility in supply chains. For example, connected pallets, containers and cars will generate data that can enhance data sharing. Cleaning and generation thus increasingly takes place in external platforms such as *Transmetrics* that exploits data driven planning.

**NAME**
Transmetrics

**COUNTRY**
Bulgaria

**YEAR**
2013-now

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | An AI driven platform that is used for analyzing, forecasting and optimizing supply chain data. This is used for data driven planning by huge companies and large logistic providers in the whole world. This is a strong example of involvement from the beginning (cleaning and generation) to end (predictive analysis). Received funding from the EU under H2020. The leave of the UK from the EU and COVID-19 are two accelerators for the company.<br><br>An example is a project for Speedy (DPD Bulgaria) in which the company implemented predictive Linehaul Planning. This allows Speedy to effectively estimate its loading factor, forecast its future volumes, and efficiently allocate resources within a growing business. In the end, the company had more insight into the loading factor visibility, hub handling problems, and non-profitable customers leading to a cost reduction of 7-9%. |
| **RESULTS** | Can provide predictive analytics of businesses and planners to make optimal decisions. The company reports 95+-% forecasting accuracy, 20% savings on network operation costs, 10% reduction in total transportation costs and 12% reduction in the employed asset fleet. |
| **CONDITIONS** | Participating parties need to have digitized supply chains and at least six months of historical data. |
| **SOURCES** | https://www.transmetrics.ai/<br>https://www.transmetrics.ai/case-study/predictive-linehaul-planning-in-express-parcel-business/#cs5<br>https://www.slideshare.net/TelematicWorldcom/transmetrics<br>https://projekter.aau.dk/projekter/files/415049475/Master_thesis_Philipp_Maronitsch.pdf https://www.code-n.org/blog/43-trucks-streets-empty-want-change-interview-logistics-startup-transmetrics/ |

## DATA DRIVEN PLANNING

Data driven planning is an application of data sharing within data driven logistics. Data driven planning is often performed within one company but has a lot of influence on other partners in the supply chain as well. Supply Chain Coordination will play a crucial role here: the more effective the coordination, the better the planning will become. Data driven planning also helps to construct sustainable logistics. The example of *Transmetrics* perfectly illustrates the possibilities of data driven planning. Within this planning, there are plenty of possibilities such as route optimization, anticipatory logistics, dock scheduling and time slot management. These functionalities are increasingly integrated in coordination platforms.

## MOBILITY INTEGRATION

The integration of mobility data such as traffic and vehicle data can be a game-changer for data driven logistics. With freight transport activities projected to increase 40% from 2005 to 2030, the integration of data to make transport and logistics more efficient can have a huge impact (Castiñeira & Metzger, 2018). This data exchange can have various applications such as predictive maintenance, road sensoring, fleet management, route planning and safety enhancement. There are several beloved projects on a national level such as FTMaas and an international level such as LOGISTAR and TransformingTransport. Furthermore, mobility integration for logistics is crucial for the adoption of sustainable logistics. The integration of mobility data brings interesting business opportunities and can be fully utilized if other data sources are integrated. *Otonomo* is an interesting example of a company that has taken advantage of the arisen possibilities within this domain.

**NAME**
Otonomo

**COUNTRY**
Israel

**YEAR**
2015-now

**STAGE**
TRL 9: Global market deployment

| | |
|---|---|
| **DESCRIPTION** | Otonomo is the world leader and provider of a pioneering platform and marketplace for vehicle data. The company is a broker between OEMs of vehicles and platforms utilizing the data. The company offers not only car data but also hazard data, road sign data, parking data and traffic data amongst other mobility data. The vehicle data can be integrated with all other types of data (for example weather data) to capture value. This connected car data can help with mapping the vehicles to increase valuable (live) decision-making. Furthermore, it can help to manage a fleet, increase safety and help with remote diagnostics. For example, the company has a partnership with Mercedes-Benz for its passenger cars and light commercial vehicles in more than 25 countries throughout Europe. |
| **RESULTS** | For logistics companies and carriers, the data can help to manage their fleets by reducing logistics and the accompanying complexity. The productivity can be boosted by less idling and reducing fuel costs. For example, companies have reported $45/month savings and $76/day for heavy use vehicles. Maintenance can be managed and the fleets can be used more efficiently. Lastly, the data can result in direct revenues. PTV Group, a software provider that supports decision-making around traffic and logistics, improved their existing traffic models using data from Otonomo. PTV found especially the data research that Otonomo performs valuable, in this way they did not have to meet the unique requirements of individual data providers. |
| **CONDITIONS** | There must be a connectivity contract with the OEM or its sales organizations for fleet management. |
| **SOURCES** | https://otonomo.io/ https://otonomo.io/blog/increase-fleet-performance/ |

## C. HUMAN INTERACTION

The interaction between data driven logistics and people is interesting in two aspects. First of all, to fully utilize the possibilities of data driven logistics people should be acquainted with knowledge about the technology and its application. This can be realized through serious games or other simulation tools. Secondly, the specific interaction between Artificial Intelligence and people should work adequately as the technology is backing, replacing, and taking over with human actions.

## KNOWLEDGE BY SIMULATION

To increase the knowledge level about data driven logistics various tools can be used. This can be used for various aspects ranging from sustainability to cybersecurity. Serious games can be used as an effective tool. Examples of these serious games are Trucks & Barges, SynchroMania, MasterShipper en Bouwlogistiek@Work. Projects on this knowledge diffusion with serious gaming enjoy a high TKI involvement. Augmented Reality of Virtual Reality environments can also be used to facilitate knowledge dissemination. On a higher level of detail, the concept of Digital Twin is exploited to accomplish various specific goals such as illustrated in the *LEAD project*. Especially the integration with IoT concepts, making simulations more realistic, can enhance compelling progression in the upcoming years.

**NAME**
LEAD Project

**COUNTRY**
European Union

**YEAR**
2020-2023

**STAGE**
TRL 7: Market demonstration

| | |
|---|---|
| **DESCRIPTION** | LEAD will create Digital Twins of urban logistics networks in six cities, to support experimentation and decision-making with on-demand logistics operations in a public-private urban setting. The cities under consideration are Madrid, The Hague, Lyon, Budapest, Oslo and Porto. The main focus is sustainability and low emission in city logistics and last-mile. Each value case will combine a number of measures named LEAD Strategies to cover the complete dynamics and complexity of a city's logistics challenges. The project focuses on the on-demand economy and hopes to support experimentation and decision making in a public-private urban setting. This support of advanced decision making through the entire logistics life cycle, while also fostering stakeholder participation via reliable real-life information is engaging. |
| **RESULTS** | Eleven cities and regions joined tailored replication program for the development and deployment of solutions on Digital Twins for city logistics, responding to increasing challenges from on-demand economy and last-mile logistics. |
| **CONDITIONS** | - |
| **SOURCES** | https://www.leadproject.eu |

### HUMAN-CENTERED AI

The specific interaction between Artificial Intelligence systems and humans has several compelling aspects and accompanying projects. This theme can be diversified into robotics, AR/VR, and AI systems. For the interrelation between robots and humans, a lot of academic research and company scale projects have been performed. In the Netherlands, there are two attractive projects: Digital Data Square Zuid-Nederland and the AI planner of the future. The first project has four test pilots regarding AR/VR/Serious Gaming, Robotics, Smart Supply Chain Contracts, and Digital Twin (Logistics Community Brabant, 2021). The second project is an ambitious extensive research program in Eindhoven and focuses on the explicit intertwining of technical and human aspects in the context of AI planning for supply chains and logistics (van der Velden, 2021).

## D. BUSINESS MODELS

Business models in data driven logistics are a delicate subject. The low margins in the logistics sector and the defensive attitude of SMEs towards data sharing highlight the importance of developments on this subject. SMEs in this way, are interpreted as the non-advancing companies on the subject of data driven logistics. SMEs also contain start-ups that are technology driven and adopt the business models that belong to data driven logistics. Following the framework of van Marwyk and Treppte (2016), the business models can be divided into three value propositions for the logistics sector: creation of online markets, process optimization, and increase of transparency. Within these value propositions, various specific business models are imaginable.

Within the creation of online markets, two forms can be distinguished: a platform model and a network orchestrator. Platform models are discussed in more detail regarding Supply Chain Coordination. A platform model is for example *Otonomo* that is a broker between OEMs of vehicles and platforms utilizing vehicle data. Network Orchestrators are defined as companies that also take part in the online market or platform themselves.

Within the process optimization, various directions can be regarded. This can be achieved by data driven planning, supply chain optimization or coordination. The example of *Transmetrics* provides an example of the process optimization value proposition.

Within the increase of transparency, various platforms enable transparency utilizing existing data. But the development of IoT transportation devices enhances this value proposition. For instance, *Ahrma Pooling* has connected pallets, increasing transparency in the supply chain.

Collaboration can be used to work on either of the value propositions and business models. An instance of this is *Open Visibility Network*, which is an extension of already existing visibility platforms with the aim to even further elaborate on this value proposition. In general, for all value propositions and business models, future example projects and frameworks can be favorable to convince companies to capture value with their data. The overarching strategy of the Dutch logistics landscape needs to serve as guidance for this theme. Especially the progress of gigantic logistics & transport companies should be considered.

# 5 CONCLUDING REMARKS

**SUPPLY CHAIN COORDINATION**
**PROF. DR. IRIS VIS**

- So far, applications are mainly developed for larger companies.
- Many startups focus on 'unbundling' traditional logistics providers.
- Visibility platforms are mostly US-based, this raises questions about use of data.
- Connecting applications or concepts show interesting potential and may extend the value of coordination beyond logistics efficiency.
- The Physical Internet is quickly becoming a feasible reality.

**SUSTAINABLE LOGISTICS**
**PROF. DR. ROB ZUIDWIJK**

- Sustainable logistics across the domains (supply chain, nodes & corridors, and cities) show both important commonalities and notable differences.
- Carbon reporting procedures have been developed for all domains; other sustainability impacts need attention;
- Impact of technological innovations (both physical and informational) are relevant and diverse (e-commerce, new modes of transport);
- Synchromodality is generally focused on modal shift, which needs not necessarily be aligned with optimizing Sustainability in all cases;
- Transition towards circular economy possibly involves additional logistics activities with social and environmental impacts, this may need attention;
- Impact of renewable energy sources creates interesting logistics challenges;
- International scope and international developments require further attention.

**DATA DRIVEN LOGISTICS**
**PROF. DR. JOS VAN HILLEGERSBERG**

- Cybersecurity is a field where the consequences may be significant, but limited action and innovation takes place in logistics.
- Standards are adopted moderately, importance for public-private exchange (integration via platforms).
- Data cleaning and generation is also a challenge yet to be addressed.
- Human factor has been granted a significant amount of attention, at least in the Netherlands.
- The struggle to show the value of data in business models remains evident.
- Data sharing is a pre-condition for data driven logistics.

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| INTERVIEWEE | ORGANISATION |
|---|---|
| Fernando Liesa | ALICE |
| Rob Zuidwijk | Erasmus University Rotterdam |
| Tomas Ambra | imec |
| Heikki Lahtinen | LIMOWA |
| Matthias Olthaar | NHL Stenden |
| Jaenett Bolther | PNO Innovation |
| Astrid Buyssen | Shell |
| Victor van der Hulst | Spark! living lab/ Windesheim |
| Gerwin Zomer | TNO |
| Harrie Bastiaansen | TNO |
| Henk-Jan Vink | TNO |
| Serge Schamschula | Transporeon |
| Lukas Kramer | Transporeon |
| Lóri Tavasszy | TU Delft |
| Ton de Kok | TU Eindhoven |
| Tarkan Tan | TU Eindhoven |
| Iris Vis | University of Groningen |
| Paul Buijs | University of Groningen |
| Ruud Teunter | University of Groningen |
| Janet Veldstra | University of Groningen |
| Nienke Vellinga | University of Groningen |
| Paul Buijs | University of Groningen |
| Jos van Hillegersberg | University of Twente |
| Sebastian Piest | University of Twente/ Port of Twente |
| Wout Dullaert | Vrije Universiteit Amsterdam |
| Sander de Leeuw | Wageningen University |

**TKI DINALOG**
Graaf Engelbertlaan 75
4837 DS Breda

info@dinalog.nl
www.dinalog.nl
+31 (0)76 531 53 00

Topsector Logistiek

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