discoverLOGISTICS

Magazine of the Fraunhofer Institute for Material Flow and Logistics IML Dortmund #26

Coverstory:

SIMPLY SHAPING THE FUTURE

Intelligent. Resilient. Sustainable.

About us

The Fraunhofer Institute for Material Flow and Logistics IML is the partner of choice for integrated logistics research. It works in all fields of internal and external logistics. In keeping with the concepts of the Fraunhofer-Gesellschaft, solutions to problems for immediate use in business are developed on the one hand, but initial research is also conducted on the other hand. Founded in 1981, the institute currently employs around 450 research associates, as well as administrative staff and workshop employees, supported by numerous student and research assistants.

Teams assembled according to project and customer requirements create cross-industry and customer-specific solutions, among other things in the field of materials handling, business process modelling, transportation systems and resource logistics. Other current research priorities include the sections of artificial intelligence and smart robotics, smart finance, the resilience of supply chains and the sustainable transformation of logistics.

For interdisciplinary projects, the institute has access to a total of 32,000 employees in 75 facilities of the entire Fraunhofer-Gesellschaft.

Locations aside from Dortmund include Frankfurt, Hamburg, Prien and Shanghai.

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Dear friends of **logistics,**

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how can we make supply chains sustainable? And at the same time resilient to crises, bottlenecks, and unforeseeable events? How can we in logistics do our part to preserve our planet for future generations, reduce CO_2-emissions, and cut down on waste? Logistics companies are currently grappling with many of these questions. As the backbone of global goods transport and the driver of many economic processes, logistics must become a systemic force for change – while logistics companies today operate in a field of tension between cost pressure, climate protection, global uncertainties, and a growing range of technologies. No easy task.

That is why Fraunhofer IML has made it its mission to work together to find solutions. In this issue, we present some of the projects that are paving the way for intelligent, resilient, and sustainable logistics. Fraunhofer IML wants to rethink the future – and sees artificial intelligence (AI) as the key to achieving this.

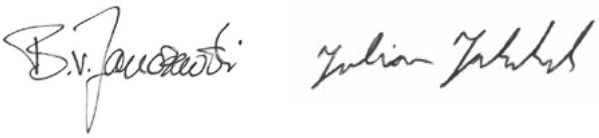
AI applications coordinate processes and ensure that everything runs smoothly. In this issue, we introduce Omnistics, a kind of toolbox with various AI tools that can be easily implemented to suit your own needs (p. 40). Especially for small and medium-sized enterprises (SMEs) that do not yet have a corresponding framework in place, such a toolbox can be a real game changer.

Another example is the manufacturer-independent fleet management system AULIS, which efficiently coordinates the journeys of autonomous robots without compromising flexibility (p. 16). Meanwhile, the SKALA research project is working on making data exchange along supply chains secure and trustworthy with the help of AI and blockchain (p. 34).

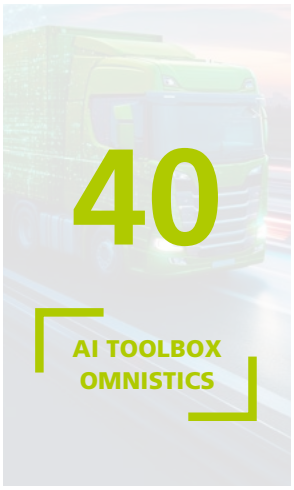
As a research institute, Fraunhofer IML also has an important social mission – and therefore makes the results of various projects freely available as open source building blocks. This applies to AULIS and SKALA as well as to the major pioneering project of the open source spirit in logistics: the Silicon Economy. The project is now complete, but it is important to keep at it and continue to make the right adjustments in the future (p. 14) – because the open source concept is not a temporary project, but rather a paradigm shift for the entire industry.

However, the many other articles in this issue also make it clear that AI, resilience, and sustainability are the strategic cornerstones for the future of logistics. Not as separate lines of innovation, but as interconnected dimensions of the future. They cannot function without each other – just like Fraunhofer IML and its numerous project partners from industry.

With this in mind, we hope you enjoy reading this issue!



The "discover Logistics" editorial team



Content

discover Logistics #26

Logistics of the Future:

More Intelligent.
More Resilient.
More Sustainable.

For decades, logistics was considered a silent efficiency machine in the background of industrial production – precise, cost-sensitive, reactive. But in the midst of climate change, global crises, geopolitical tensions, digital transformation and regulatory upheaval, it is becoming clear that logistics is no longer just a service provider. It is becoming a systemic shaping force for a networked, sustainable and resilient society.

Images: Anton Balazh, InfiniteFlow – stock.adobe.com

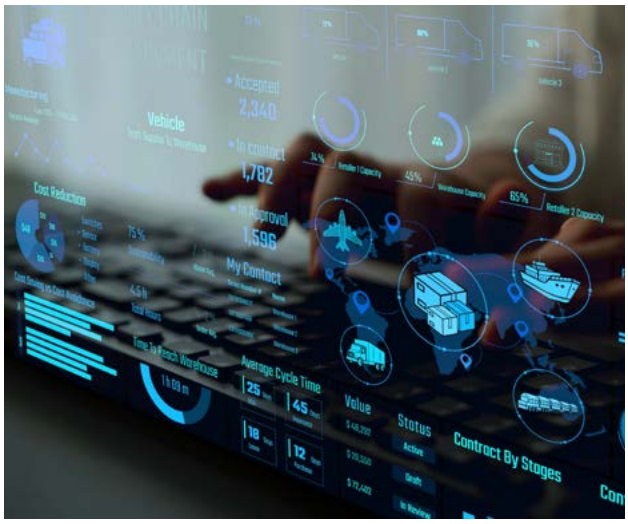
Today, the logistics industry faces a dual challenge: on the one hand, it is the backbone of the global movement of goods and the driver of many economic processes. On the other hand, it is confronted with complex problems that are both operational and strategic. One of the central problems lies in the complexity of its own value chains. Many logistics companies struggle with fragmented IT systems, a lack of interfaces and a system landscape that has often evolved over time, making digitalization difficult. Added to this is the enormous need for investment: New technologies not only require high initial investments, but also qualified HR officers who can handle the new systems. Small and medium-sized enterprises (SMEs) in particular are reluctant to make such long-term commitments in the face of uncertain market developments. Regulatory uncertainties, volatile markets, geopolitical crises and a shortage of specialists also act as a brake on innovation.

"The answers to the global challenges we face today are provided by digitalization, automation and, in the future, autonomization."

Prof. Dr. Dr. h.c. Michael Henke

Artificial intelligence: potential for planning, forecasting and optimization

Despite all the hurdles, the use of artificial intelligence (AI) in logistics is progressing steadily. In 2022, around 22% of German logistics companies were already actively using AI, with a further 26% planning or discussing its use. The possible applications are diverse: the scenarios range from demand forecasts, route and sales planning to the real-time optimization of transports and warehouse processes. Empty runs can be reduced, routes dynamically adapted and capacities used more efficiently. More than half of the companies assume that AI will soon find its way into logistics across the board. Compared to the economy as a whole, the logistics industry is a pioneer of digitalization.



"Companies that are particularly successful in digitalization are often linked by a willingness to train their employees and to invest. They cooperate with Research and have an overarching systemic understanding of logistics."

Prof. Dr.-Ing. Uwe Clausen

Sustainability: climate targets as a driver of innovation

At the same time, the pressure for decarbonization is growing. The transport sector is responsible for around 22% of CO_2 emissions in Germany, a third of which is attributable to freight transport. Sustainability is no longer a nice-to-have, but a regulatory and social obligation. Around 62% of logistics companies rely on digital technologies to reduce emissions and make processes more sustainable. The use of electric and hybrid vehicles, alternative drive systems in shipping and sustainable aviation fuels is steadily increasing. The global market volume for green logistics is forecast to reach around 1.5 billion US dollars by 2028.

"Sustainability is very important for younger generations."

Prof. Dr.-Ing. Alice Kirchheim

Resilience: making supply chains more resistant

The recent crises have shown how vulnerable global supply chains can be. Although many companies now consider their supply chains to be more robust than before the pandemic, resilience remains one of the biggest construction sites. While 79% of companies at least monitor the first tier of suppliers, only 14% also monitor the lower levels of their supply chains. There is a considerable hidden risk here, which can quickly cause operational disruptions in crisis situations. According to the FM Resilience Index 2025, Germany still performs well in a global comparison:

The country ranks third out of 130 markets analyzed in the logistics sector, thanks in part to its high-performance infrastructure and economic stability.

"The comprehensive management of supply chains requires deep-tier transparency. This is where enormous data treasures lie that can be harnessed with the help of AI and used to build resilient and sustainable supply chains."

Prof. Dr. Dr. h.c. Michael Henke

Pressure to innovate as a permanent condition

These figures show: Logistics companies today are operating in a field of tension between cost pressure, climate protection, global uncertainties and a growing range of technologies. AI, sustainable solutions and resilient supply chains are no longer optional projects, but essential building blocks for the future viability of the industry. Those who invest today are laying the foundations for operational excellence, competitiveness and the fulfillment of social expectations. However, the transformation process is demanding technological expertise, strategic foresight and smart change management.

Fraunhofer IML is at the heart of this transformation. It is rethinking logistics: as an adaptive, self-organizing, ecologically responsible system. The strategic cornerstones of this new logic are artificial intelligence, resilience and sustainability. Not as separate lines of innovation, but as networked dimensions of the future.

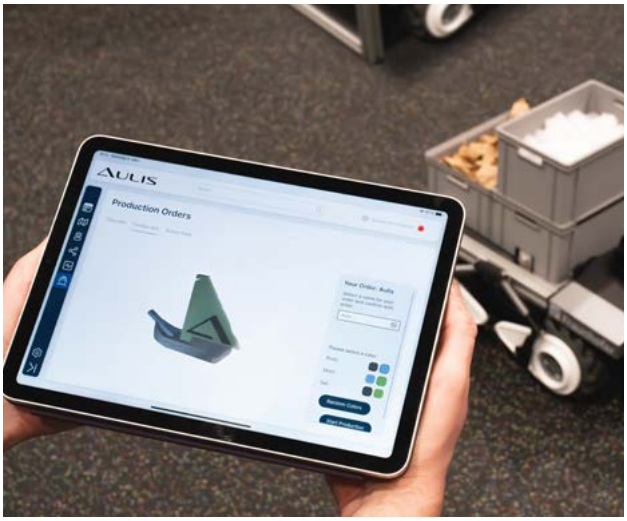
"Resilient supply chains and logistics systems help us to cope well with increasing uncertainty caused by political, weather-related or technical disruptions."

Prof. Dr.-Ing. Uwe Clausen

AULIS: Intelligent fleet management for autonomous intralogistics

A key example of this paradigm shift is Aulis – a modular, agent-based operating system that efficiently organizes internal material flows with automated guided vehicles (AGVs) and autonomous mobile robotics (AMRs) (see also p. 16). The special feature: Aulis is manufacturer-independent, is based on open de facto standards such as the German Association of the Automotive Industry (VDA) 5050 or M2X and is provided as open source. The result is a genuine plug-and-play system that can be flexibly integrated into existing IT architectures.

Aulis addresses the central challenges of modern production logistics: the modular architecture allows processes to be adapted precisely to operational conditions. Companies can combine, expand or replace individual modules – for example for order placement, routing, optimization, vehicle control or user interfaces – as required. Communication takes place via the open IoT message protocol MQTT or alternatively via other established protocols. The result is a highly customizable, future-proof system that enables cross-manufacturer interoperability.



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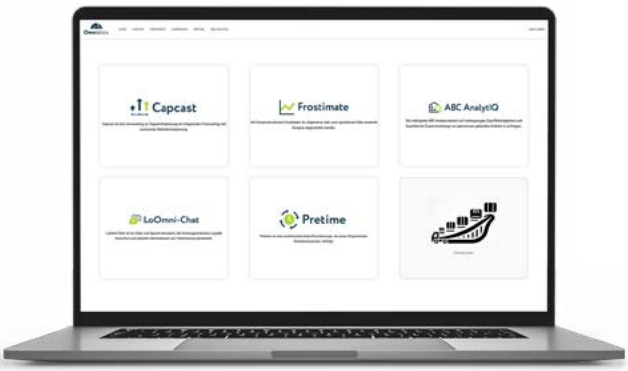
The order agent: modular structure with data sovereignty

The diversity of the Aulis modules reflects their functional depth: the order agent administers production and transport orders and integrates with ERP, WMS and MES systems. The routing agent plans time-optimized routes, while the optimization module distributes orders intelligently and efficiently. Vehicle agents translate control commands for different robot models. And the user interface module visualizes processes in real time – mobile, interactive, clear. The decisive factor here is the freedom to choose where Aulis is operated – in the cloud, on edge systems or on-premises - in the spirit of sovereign data management.

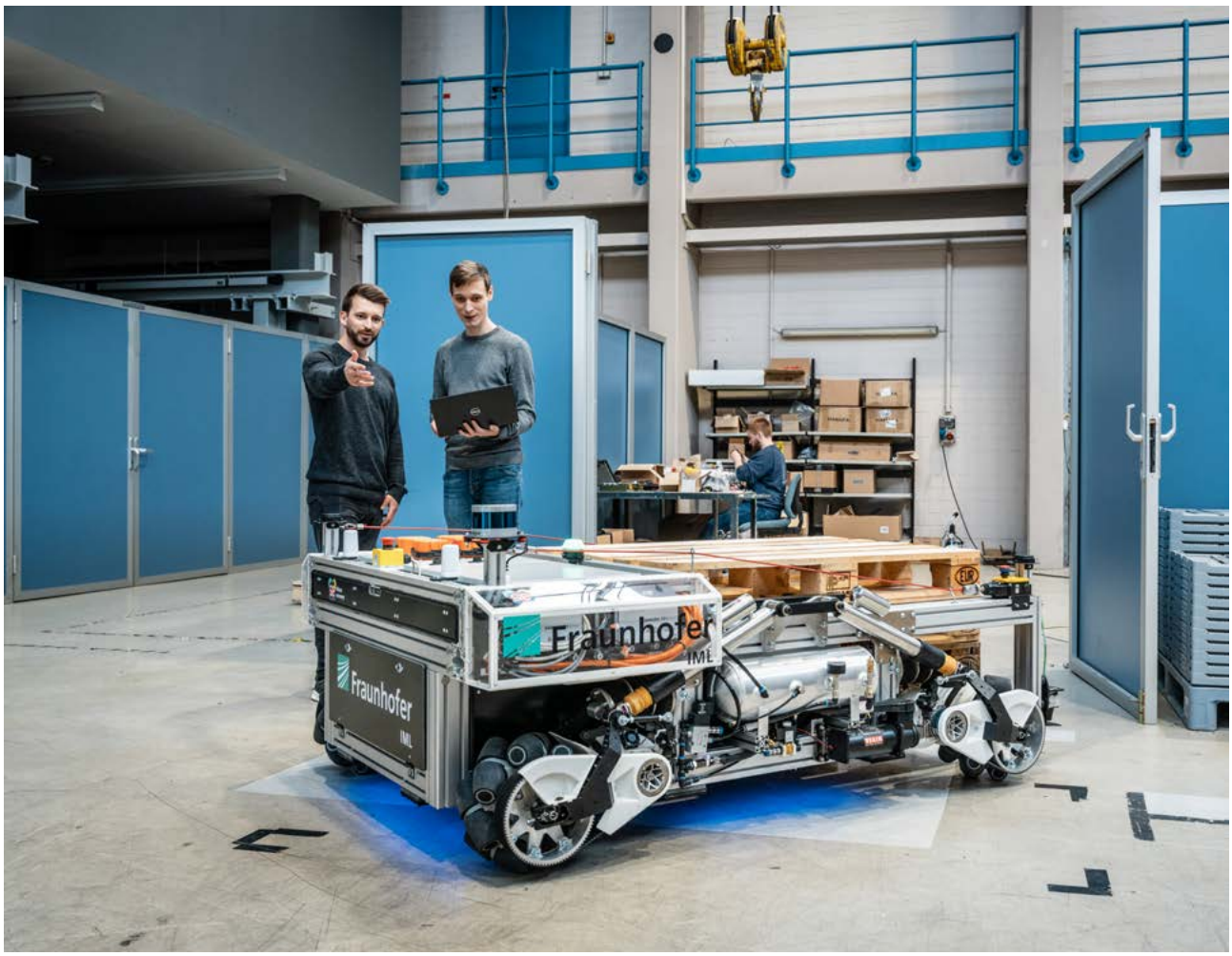
SKALA: Trustworthy value creation through AI and blockchain

While Aulis focuses on internal processes, SKALA looks at inter-company data flows (p. 34). The project, which is funded by the German Federal Ministry for Digitalization and Government Modernization (BMDS), aims to combine AI and blockchain technology to create a trustworthy, open infrastructure for the value chains of tomorrow. The focus is on the transparent, secure and at the same time sovereign sharing of data – from traceability along the supply chain to smart contracts and the digitalization of document flows. Open source-based software modules give SMEs in particular access to technological excellence without having to tie themselves to proprietary providers.

Omnistics: artificial intelligence as a service



A similar openness also characterizes the Omnistics platform (p. 40). It stands for low-threshold access to artificial intelligence – especially for companies without a fully developed IT infrastructure. As an AI-as-a-service toolkit, Omnistics offers various specialized applications: Capcast for precise capacity forecasts, Pretime for predicting multimodal arrival times, LoOmni-Chat as an intelligent voice and knowledge assistant or Frostimate for calculating market-driven freight rates. All modules are based on trained AI models and can be flexibly ported to your own hardware or connected via open interfaces. In this way, digitalization becomes a tool rather than a hurdle.



Silicon Economy: from automation to cognitive logistics

The basis for many forward-looking research projects lies in the "Silicon Economy" (p. 14). Since 2020, Fraunhofer IML has been pursuing a visionary flagship project as part of the BMV-Innovation Program Logistics 2030, focusing on the development of an upcoming digital infrastructure or digital ecosystem. This is based on the automated negotiation, scheduling and control of goods flows. The aim was to enable new digital business models – and not just for logistics. The project combines digital infrastructure, artificial intelligence and open source to create a new logistics operating system. The aim was fully networked logistics in which software agents act autonomously, exchange information in real time, negotiate contracts digitally and make decisions – securely, interoperably and trustworthily.

The special feature: All the components developed – from identity services and transport contracts to routing algorithms – are made available as open source via the Open Logistics Foundation, also initiated by Fraunhofer IML. Strictly speaking, the Open Logistics Foundation is a strategic network for the development of standardized, open-source software solutions in logistics. Open communication interfaces (so-called APIs), data models and reference implementations are created here – all with the aim of enabling interoperability and platform neutrality in the digital logistics space. Companies of all sizes can use these building blocks, expand them and integrate them into their own systems. This creates a federated innovation ecosystem that secures digital sovereignty for European logistics beyond proprietary platform giants. This is complemented by the Open Labs initiative, in which companies join forces with Fraunhofer IML in specific development partnerships. This not only results in knowledge transfer, but also the direct exploitation of AI-based technologies in operational reality.

"The basis for resilient and sustainable logistics systems are fully digitalized business processes, because this makes it possible to determine the actual situation, define a target state and continuously monitor the path to it."

Prof. Dr.-Ing. Alice Kirchheim

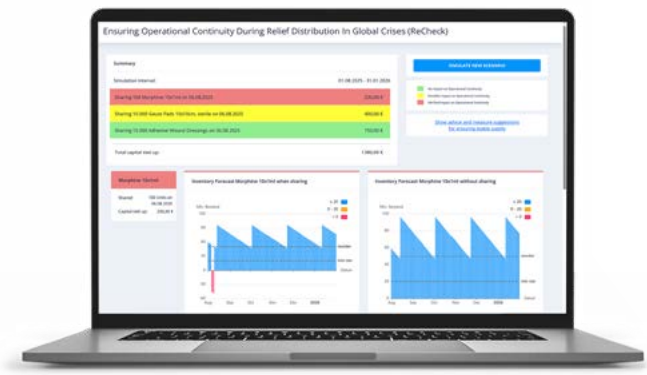
Images: guteksk7 – stock.adobe.com, Fraunhofer IML

Platform strategies and data ecosystems: Networked logistics

With the Silicon Economy and related initiatives, Fraunhofer IML is therefore driving the transformation of supply chains into platform-based value creation systems. Data is not collected in isolation, but shared, processed and evaluated along standardized protocols in real time – with full protection of data sovereignty and security. These platform strategies enable seamless process chains between manufacturers, logistics service providers and customers, transparent CO_2 balance sheets for every transport route, automated contract processing based on smart contracts and more resilient decision-making processes thanks to digital redundancies.

A core requirement for this platform logic is semantic interoperability – i.e. the understanding of data across system boundaries. Fraunhofer IML is developing standardized data models for logistics objects, semantic translation layers, tools to ensure data quality and open reference architectures that enable SMEs in particular to access the platform world. The technological highlight lies in the balance between openness, security and functionality – this is the only way to turn platform logistics into a sustainable infrastructure.

Resilience: logistics systems that are prepared for uncertainty



The Covid-19 pandemic has revealed just how vulnerable global and regional supply systems are to crises. The "ResKriVer" project, which is being run by Fraunhofer IML together with partners from research, administrative staff and healthcare logistics, aims to develop a digitally supported platform for crisis preparedness and response (p. 32). The focus is on recording requirements and inventories in real time, prioritizing the allocation of scarce goods with the help of AI, visualizing available transport resources and supply bottlenecks and developing scenarios for preventive resilience measures.

One of the most powerful foundations for resilient networks is the development of digital twins of logistics systems. Fraunhofer IML has a broad project base on this topic – including in cooperation with partners from the automotive, chemical, food supply and logistics service sectors. Digital twins make it possible to simulate supply chain disruptions such as interruptions in Asia or shifts in demand in Europe, analyze vulnerabilities and single-source dependencies, test alternative logic and transport paths and thus develop robust system architectures. In combination with AI, predictive, self-adapting systems are created that learn from real-time data and automatically reconfigure themselves if necessary.

The supply chain engineering research strategy being developed at Fraunhofer IML replaces thinking in terms of rigid chains with a concept of dynamic, reconfigurable value creation networks. This includes the modular structuring of supply chains with built-in alternatives and redundancies, continuous real-time monitoring of critical paths and the integration of decentralized manufacturing and storage units such as 3D printing centers or urban micro-hubs. Resilience thus becomes a system quality – economically viable, technologically sound and socially responsible.

"Only resilient supply chains are economically successful and therefore sustainable"

Prof. Dr. Dr. h.c. Michael Henke

Sustainability: logistics as an ecological system responsibility

As part of the EU Green Deal and the Circular Economy Regulation, the digital product passport is becoming a central tool for Sustainability and traceability. Fraunhofer IML is working on technological foundations and practicable standards to document the carbon footprint and material composition over the entire life cycle of a product. In addition, information on reparability, origin or recycling options can be systematically stored. Manufacturers, retailers, logistics providers and waste disposal companies are networked via a common data platform. The digital product passport is

therefore not just a regulatory obligation, but also a strategic tool for making sustainable decisions.

"If consumers demand sustainable products and sustainable business practices, they will prevail. And part of my job is to create this awareness among consumers."

Prof. Dr.-Ing. Alice Kirchheim

Fraunhofer IML is also involved in numerous initiatives for emission-free urban logistics. These include the integration of autonomous delivery vehicles in urban micro-depots as well as the coupling of hydrogen infrastructure with multimodal transshipment points. In addition, platforms for ecologically optimized route planning are being developed. The combination of AI, sensors and a sustainable transport strategy is creating intelligent ecological logistics that combines economic efficiency, environmental protection and quality of life.

ForestGuard: open source blockchain for deforestation-free supply chains

There is also a need for information on the implementation of the EU Anti-Deforestation Regulation (EUDR). However, companies often lack sufficient, reliable and tamper-proof data from their supply chains. The ForestGuard project (discover logistics reported in issue #25) is developing a practice-oriented, scalable open-source solution that enables digital verification by combining various technologies such as blockchain and distributed ledger technology. In the pilot project, the application was tested using the example of a coffee supply chain, whereby stakeholders along the entire chain can store tamper-proof data such as geodata, proof of ownership and freedom from deforestation. This information serves importers, among others, as a basis for due diligence declarations to the EU information system and facilitates the documentation and tracking of production and logistics processes. Smallholder producers in particular benefit from the improved administrative staff of their cultivated areas and crop yields. ForestGuard also offers functions for risk assessment, reporting and compliance with regulatory requirements in accordance with Article 9 of the EUDR. The open-source release of the tool took place at the end of January 2025 by Fraunhofer IML, the project was realized with partners such as REWE, Schirmer Kaffee and a coffee cooperative in Peru. In addition to the project results, the potential of digital transparency solutions for sustainable, social and ecological improvements in global supply chains was also discussed at the closing event.

Research halls and labs: from prototype to practice

A unique selling point of Fraunhofer IML is the consistent combination of basic research with practical application. In the institute's research halls and labs, new technologies are tested, adapted and industrialized in real environments. This is where demonstrators for autonomous material flow systems, AI-supported transport planning, networked human-

machine interactions, sustainable packaging solutions and digital proof of delivery are created. Companies can not only test, but also co-develop – directly on site, interdisciplinary and with scientific support. The labs are therefore more than just technology showrooms: they act as catalysts for transformation capability.

After all, new technologies are often difficult to grasp, especially for SMEs. Fraunhofer IML therefore creates low-threshold demonstrators that allow use cases to be experienced in a practical way – such as a digital transport register with automated CO_2 balancing, a modular AI stack for real-time shipment tracking or a digital twin of an urban handling system. The aim is to create trust in technologies – through transparency, shareholdings and concrete application proximity.

"Sustainability remains a requirement for logistics, for which we offer good solutions."

Prof. Dr.-Ing. Uwe Clausen

Technology transfer: qualification, SMEs and human factors

At Fraunhofer IML, openness to technology also means creating access. SMEs in particular need solutions that are connectable – technically, organizationally and culturally. Fraunhofer IML offers support with technology transfer, further education formats such as summer schools and future skills training, participative innovation workshops and tool-based guidance for the introduction of AI, the Internet of Things (IoT) and digital twins.

Last but not least, Fraunhofer IML places people at the center of the transformation. The focus is on adaptive assistance systems that support employees in complex environments, ergonomically designed human-technology interfaces and participatory design processes in which employees themselves are actively involved in the development of new solutions. The vision is logistics that grows with people rather than against them – inclusive, flexible and meaningfully digital.

Outlook: Systemic intelligence as a vision for the future

Aulis, SKALA, Omnistics and the other projects mentioned are not individual initiatives. They are part of a systemic ecosystem in which technology development, open source, standardization and social benefits go hand in hand. Fraunhofer IML is thus creating more than just functioning systems – it is shaping a new logic of logistics: open, decentralized, adaptive and sovereign. The logistics of the future will no longer be linear, reactive or invisible. It will become the strategic control instance of a networked world. It not only organizes the flow of goods, but also orchestrates information, energy distribution, resource efficiency, system resilience and sustainability. In the context of Industry 5.0, the EU Green Deal, CSRD, the Supply Chain Act and the EU Digital Strategy, it is also becoming clear that logistics is no longer a purely operational area – it is becoming politically, ecologically and socially relevant. With its projects, platforms and partners, Fraunhofer IML is working precisely at this interface. It thinks of logistics not just in technical terms, but systemically – as an integrative component of a future viable Europe.

"Silicon Economy" – There Is no Alternative to **Open Source**

No development without application: that is what Fraunhofer IML concluded when research on the Silicon Economy research began. Back then, the overarching goal was to develop a decentralized, open platform economy "made in Germany".

What unfolded in the following years was not yet foreseeable. At the end of 2024, funding for Silicon Economy Research – and with that one of the largest research projects in logistics – came to an end. The project was funded by the German Federal Ministry for Digital and Transport (BMDV) with a total of approximately 35 million euros. Between May 2020 and the end of 2024, Fraunhofer IML and the Fraunhofer Institute for Software and Systems Engineering ISST, together with various chairs of the Technical University of Dortmund, worked on new approaches for the use of open source in logistics with more than 150 researchers in close cooperation with industry. More than 20 development projects were implemented and numerous hardware and software components were developed.

The funding project was also served as launch pad for the Open Logistics Foundation which continues the new collaboration on a private-sector basis. The foundation was established as early as 2021 by Dachser, DB Schenker, duisport and Rhenus. The core of the foundation's work is the operation of a technical platform on which software and hardware, interfaces, reference implementations and components are available open source under a permissive license – the so-called Open Logistics Repository. The major goal of a decentralized platform economy was thus already achieved in 2021.

The Silicon Economy components – freely accessible to all

The components developed by the researchers range from digital consignment notes (eCMR) and preparations for EU-wide digital freight information (eFTI) to AI-based estimated time-of-arrival services, IoT devices and dynamic transport robots, such as the evoBOT® or O³dyn. Most of the components developed by the researchers serve as a basis for the use of artificial intelligence (AI) in logistics or are AI-driven. AI holds tremendous potential for optimizing and automating processes in logistics in particular. Publishing these as open source and making them freely accessible also serves to drive innovation in the logistics industry, especially in automation and digitalization. Companies of all sizes have the opportunity to further develop solutions together and establish de facto standards.

Research on research

At the conclusion of this major research project, Fraunhofer IML, in collaboration with the consulting firm Deloitte, also took a scientific look at Silicon Economy research. In a study, the researchers analyzed all previous results of the research project and identified further research and funding needs. They also derived further recommendations for action to continue to drive forward the digitalization of logistics.

Five fields of action were analyzed: Technology, processes, methods, incentivization and regulation.

Technology

Digital standards, such as open APIs, data models and process definitions, must be further developed jointly in order to create a solid foundation for digitalization.

Processes

An industry-wide awareness of value creation and collaboration in digitally networked ecosystems is required, along with imparting business model know-how and platform logic.

Methods

To foster interest in the collaborative development of open-source solutions, the economic viability and benefits of active participation by companies in open-source software development must be investigated and made quantifiable.

Incentivization

It should be determined which incentives, such as government funding, can support and motivate companies to engage more actively in open source development and, as a result, bringing the vision of the Silicon Economy closer to reality.

Regulation

In order to ensure not only the establishment of de facto standards via open-source projects but also a gradual transfer of research results into standardization procedures, future implementations of new laws and regulations regarding digitalization should involve joint efforts by public authorities, companies and research institutions.

Silicon Economy awakens open source spirit of the logistics industry

After more than four years of Silicon Economy research, several milestones in the digitalization of the logistics industry have been achieved. The study emphasizes that there is still untapped and that digitalization and the resulting international competitiveness of the entire industry can also be driven forward by open source.

"In more than four years of Silicon Economy research , we have laid a strong foundation to continue the digitalization of logistics. Above all, we have succeeded in creating an open source spirit and engaging even major logistics players with it. That would have been unthinkable a few years ago. Our closing study strongly highlighted once again, – that we need to stay focused now and make the right adjustments for the future, both in logistics research and in practice," emphasized Prof. Michael Henke, director at Fraunhofer IML, on the occasion of the study's publication.

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The New Logic of Intralogistics:

Into the Future With Aulis

How a modular operating system controls autonomous robot fleets – and companies regain their sovereignty

The world of logistics is changing. Autonomous mobile robots (AMR) and automated guided vehicles (AGVs) are increasingly conquering the intralogistics halls. However, as diversity and complexity increase, so does the need for intelligent, flexible fleet management – one that not only works across manufacturers, but is open, modular and future viable. This is precisely where "Aulis" comes in. A system that not only orchestrates processes, but also creates new degrees of freedom for companies.

"We wanted to develop a system that is not dependent on one manufacturer or proprietary standards – but one that is open, adaptable and at the same time technologically leading," says Dr. Peter Detzner from Fraunhofer IML. Aulis is exactly that: a modular, agent-based operating system that raises the internal material flow to a new level.

Autonomous fleets on course: the Aulis principle

Aulis was developed to control heterogeneous fleets – fleets of AGVs (automated guided vehicles) and AMRs (autonomous mobile robotics) from different manufacturers, with different control systems, capabilities and deployment scenarios. The highlight: instead of linking rigid systems, Aulis relies on a modular agent concept. Individual software modules, known as agents, take on specific tasks – from placing orders and route planning to optimizing the entire transport system.

"The whole thing works like a modular system," explains Detzner. "Companies can choose exactly the modules they need – and add new ones or adapt existing ones as required." Aulis relies on open de facto standards such as VDA 5050 or M2X throughout. This enables genuine interoperability. "We didn't want to create a new isolated solution, but rather build a bridge – between systems, manufacturers and applications."

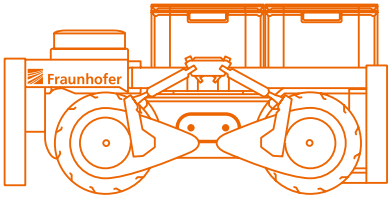
Flexibility meets real-time intelligence

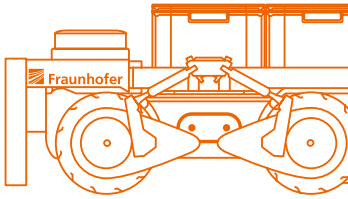
The system currently consists of five main modules: The order agent takes care of the creation and processing of transport orders, networking directly with existing ERP, WMS or MES systems etc. The routing agent plans routes in real time – and always with an eye on current transportation and order situations. The optimization module ensures intelligent distribution of transport resources. Vehicle agents take over communication in accordance with the VDA 5050 standard with the AGVs and AMRs. And the user interface module provides all the information in a clear format – for mobile devices as well as for desktop control stations.

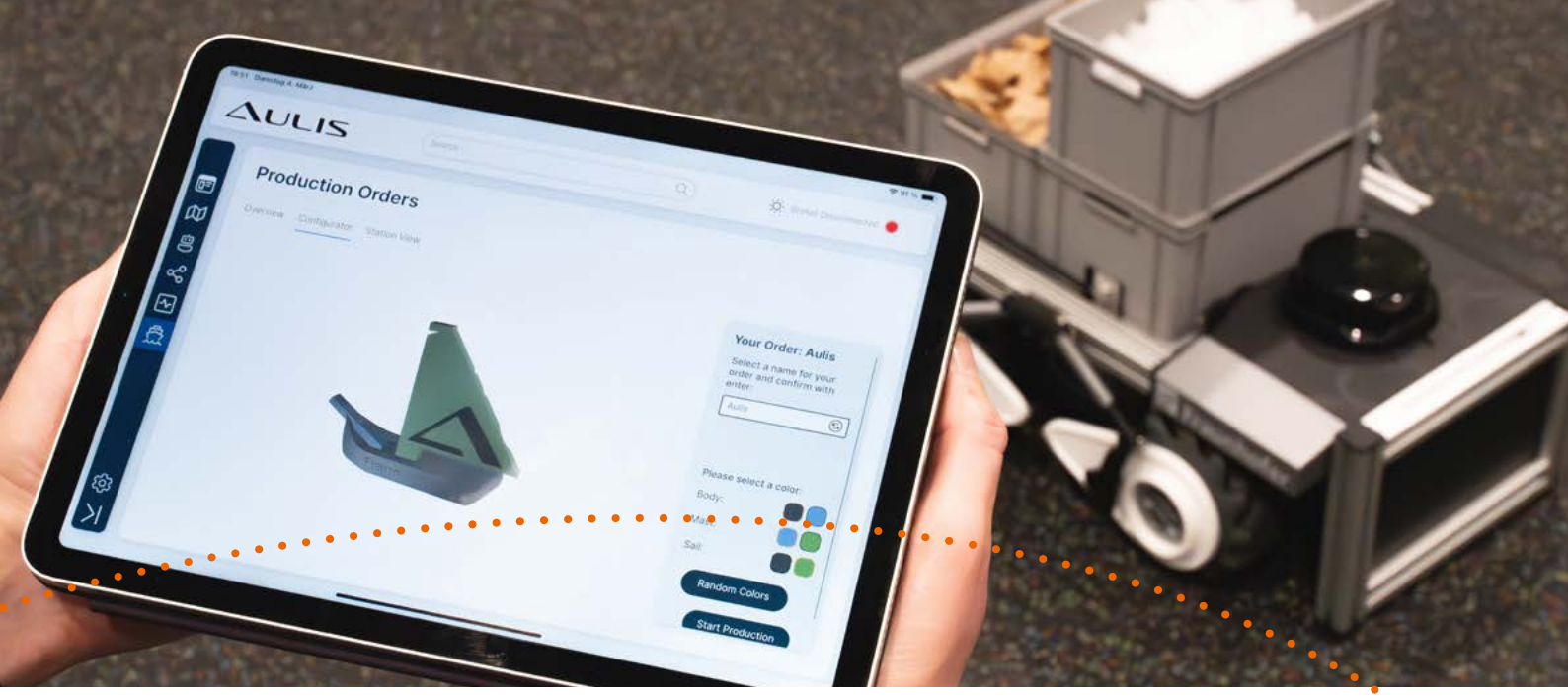
"One of our most important principles is data ownership," emphasizes Detzner. "That's why Aulis can be operated not only in the cloud, but also at the edge or on-premise, i.e. directly at the user's premises. This means that the data remains exactly where it is generated." Companies retain control over their data at all times – an important factor, especially in regulated or security-critical areas.

Simulation and reality in harmony

Aulis not only impresses with its functionality, but also with its ability to integrate virtual environments, augmented reality. This allows real mobile robotics to be combined with simulated AMRs or AGVs – an effect that Fraunhofer IML has impressively demonstrated with the LARS laser projection system (p. 18). "With LARS, we can make production







and logistics processes visible in space and actively involve people," explains Detzner. Mixed reality thus becomes a bridge between the digital twin and physical reality.

One system, many users – open to SMEs

Aulis is not just aimed at large manufacturers or integrators – on the contrary. Small and medium-sized companies (SMEs) in particular benefit from the openness of the system. "SMEs need solutions that are not expensive, heavyweight or difficult to integrate," says Detzner. "Aulis offers exactly that: a lean system that can be integrated with little effort and still meets the highest standards."

The system offers advantages on many levels: From cost efficiency thanks to open source and permissive licensing to independence from specific manufacturers and the ability to develop your own modules – adapted to the individual use case.

The platform concept consistently taken further

However, Aulis is also based on a new understanding of innovation: openness, participation and networking. By making the software available as open source, a broad community is involved. "We can, but don't want to develop everything on our own – we want to create a strong ecosystem together with users, research partners and system manufacturers," explains Detzner.

Fraunhofer IML is also taking this idea further with the SKALA project (p. 34). This is about trustworthy, decentralized data processing across company boundaries – an elementary building block for data-based value creation networks. Artificial intelligence (AI), blockchain technologies and open standards form the technological basis here.

AI for everyone – with Omnistics

Another piece of the puzzle in Fraunhofer IML's system thinking is the Omnistics platform (p. 40). "AI should not only be accessible to large companies, but should be made available and usable for everyone," says Detzner. Omnistics offers applications such as Capcast (for capacity forecasts), Pretime (for arrival time predictions), LoOmni Chat (a knowledge assistant) and Frostimate (for freight rate calculation). All services can be used flexibly as AI-as-a-Service and expanded as required.

An operating system that is more than just technology

Ultimately, Aulis is more than just another fleet management system for controlling mobile transport robots. It is an expression of a new way of thinking: modular, open, networked. It combines technical excellence with user orientation, data ownership with innovative spirit. "Aulis is not just software," summarizes Detzner. "It is a contribution to a new culture in logistics – one that enables collaboration instead of excluding it. One that relies on standards instead of proprietary solutions. And one that brings people, systems and machines together in a real network." In this way, an operating system becomes an enabler for smarter, more flexible and more human logistics. All in the spirit of a future that is not only digital – but also sustainable and collaborative.

to the video

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Orientation by Light Track –

How LARS Is Rethinking Intralogistics for People

With lasers, software and a lot of vision: With LARS, Fraunhofer IML is developing a flexible projection system that guides logistics employees through warehouses in real time – intuitively, safely and ergonomically. A conversation with the researchers responsible shows just how much the future can hold in a beam of light.

Rico Ahlbäumer quickly gets to the point when asked about the core of LARS: "We don't want to put on a show with LARS, we want to provide real help. It's about taking the strain off people in day-to-day warehouse operations and making processes safer, clearer and faster."

LARS stands for "Laser-AR-Safe" and is a dynamic guidance system that uses laser projection to project information directly onto the floor – where it is needed. Sometimes a blue arrow shows the way to the right ramp, sometimes a green marker is displayed to indicate the destination for a pallet. What appears simple at first glance is technologically highly sophisticated and ergonomically well thought out. "LARS is designed for human-powered logistics," says Ahlbäumer. "Our aim is to create orientation using simple but effective means – especially for new or unskilled employees."

Projection power meets process intelligence

The system uses special laser projectors that are safe for the human eye. However, the real innovation is in the software: LARS controls the lasers in real time and connects them to existing systems such as ERP, WMS or MES. "Technically speaking, we have developed an interface for controlling laser shows," explains Ahlbäumer. "This interface allows us to generate highly dynamic, colourful visualizations and thus control work processes."

The system has a modular structure. "We can display all kinds of things: Arrows, stop signs, parking space markings or danger zones. Depending on the customer's requirements," says Ahlbäumer. The application scenarios range from picking and consolidating to (de-)palletizing or sorting.

In test operation: laser light instead of paperwork

A current use case demonstrates the strengths of the system: "We are currently testing the projection of pallet storage locations in a warehouse with a partner company," reports Ahlbäumer. "As soon as the shift supervisor starts the process, the forklift drivers can see on the floor where they have to place their pallets. No note, no radio message – just a clear light pulse."

Five lasers are sufficient to provide instructions in up to twelve lanes on an area around 30 meters wide. The projection surface depends on the height of the hall, but the principle remains the same: bringing information directly to where it is needed. "This not only saves time, but also reduces errors," says Ahlbäumer.

Light against language barriers and the shortage of specialists

An important driver for LARS was the increasing shortage of specialists. "In many warehouses today, people work who don't speak our language well or are barely trained. A system that works with symbols, numbers and colors helps tremendously," says Ahlbäumer. "Instead of long texts or cryptic picking slips, there is a clear indication on the floor – intuitive, unambiguous, immediately understandable."

This is a particular advantage for temporary workers or seasonal peaks. LARS significantly shortens the training period and improves safety at the same time. "If a forklift truck approaches, LARS can display a virtual exclusion zone, for example. That's a benefit for everyone involved," says Ahlbäumer.

The technology in the background: safe, flexible, open

The system is deliberately designed to be open. "We didn't want an isolated solution," emphasizes Ahlbäumer. "That's why LARS can be connected to various existing systems and works via a modular software architecture."

The RGB lasers used are extremely bright and enable the display of any colors and shapes. A special lens provides the necessary beam divergence to ensure maximum safety. This lens systems allows the laser to be very bright. This is a particularly important aspect in modern warehouses, which also offer daylight. According to Ahlbäumer, the lasers used are also safe: "The laser is tuned in such a way that it remains below the limit values and can therefore also be approved by the technical monitoring institutions without any problems."

LARS is also scalable and can be expanded to include additional projectors or functions if required. "Our system is like a construction kit: if you want to start small, you can. If you want to build a complex control system, you have all the options at your fingertips," says Ahlbäumer.

Related technologies: How AULIS and LARS work together

The combination with the AULIS system (p. 16), which was also developed at the Fraunhofer IML, is particularly attractive. While AULIS is a modular operating system that organizes the transport of goods using autonomous mobile robotics (AMR) and automated guided vehicles (AGV), LARS supports human employees.

"In modern logistics, people and machines have to work together. AULIS regulates the transportation of the robotics, LARS shows the humans where to go," Ahlbäumer sums it up.

The interaction is clearly evident in applications where AMR fleets navigate through a Hall and LARS simultaneously projects visual guidance for the humans. "This reduces collisions, improves ergonomics and increases process speed," says Ahlbäumer.

Visions for the future: navigation system for the shop floor

LARS is still a system with a lot of potential for further applications. "We see LARS as a navigation system for the shop floor," says Ahlbäumer. "In the long term, however, we can imagine using it to map entire work instructions, safety routines or route guidance."

Extensions with additional sensor systems or cameras are also conceivable. In the future, LARS could react to current situations and automatically display an alternative route in the event of an incident, for example.

Conclusion: a ray of light for greater efficiency and safety

LARS is definitely much more than just a technological gadget. It is an example of a human-centered approach to innovation that uses technology not for its own sake, but to address specific problems. In times of a shortage of specialists, increasing cost pressure and growing complexity in intralogistics, a smart beam of light could make all the difference.

"We are currently looking for partners who want to develop LARS with us," says Ahlbäumer. "The potential is huge, and we're only just getting started."

And who knows – maybe LARS will soon be standard in every Hall – as a silent companion in everyday working life that provides orientation with light and never gets in the way.

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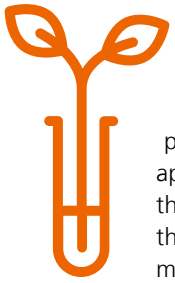
A Duty Instead of a Choice: **Sustainability** as a **Benchmark**

The concept of sustainability has been shaping everyday life in our society for some time now: Where does my electricity come from? Combustion engine or electric car? Are my vegetables locally grown? What are often just considerations in everyday life are much more complex on an industrial level. It is not enough to produce meaningful sustainability reports; their effectiveness must also be verifiable. This is where the AI tool "Sustainalyze" from Fraunhofer IML comes into play. This tool is designed to standardize and analyze key figures and data and prevent the concealment of facts.

In Germany, the current legal basis for sustainability reporting is the Corporate Sustainability Reporting Directive Implementation Act (CSR-RUG), which has been in force since 2017. It requires large, capital market-oriented companies with more than 500 employees to disclose information on environmental, social and governance (ESG) topics. This is done using key figures such as greenhouse gas emissions, anti-corruption measures, and working conditions. On the EU level, the CSR Directive (CSRD) came into force in January 2023. It significantly expands the scope and depth of reporting requirements, introducing mandatory EU-wide reporting standards (ESRS), external assurance and the principle of double materiality. The CSRD must be transposed into national law by July 2024 and will gradually apply to more companies – including listed SMEs starting in 2026. CSR-RUG and CSRD are two separate regulatory frameworks with different scopes and requirements. While CSR-RUG remains applicable for now, CSRD paves the way for a broader and more harmonized approach to sustainability reporting across the EU.



One of the biggest challenges is the often-incomplete database, which increases the risk of greenwashing. This means that companies sometimes "paint themselves green" by appearing more environmentally friendly than they actually are – with the aim of improving their image and winning customers through misleading statements.

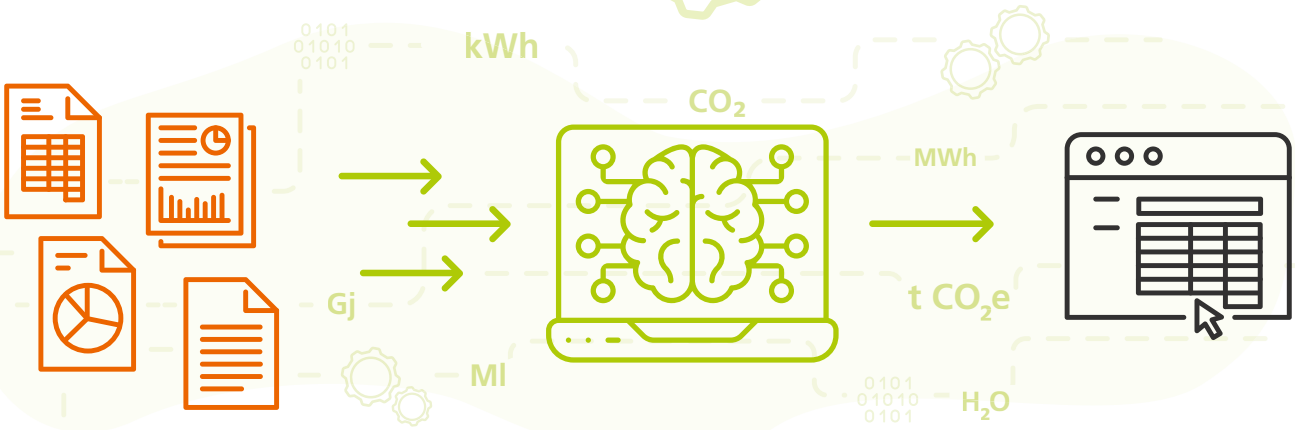
Efficient evaluation of sustainability goals with AI

The project team led by Pia Schreynemackers at Fraunhofer IML has developed the "Sustainalyze" tool for analyzing sustainability reports. "In a world where sustainability is becoming increasingly important, there is also growing pressure on businesses to produce credible and meaningful reports," explains Schreynemackers.

Using an algorithm and large language models, "Sustainalyze" reads sustainability reports, captures their semantic content, and makes them comparable and assessable by providing a structured summary. The algorithm is based on machine learning: artificial intelligence (AI) compares the raw data using selected criteria. To ensure transparency, comparability, and objectivity, only publicly available data is used. In the end, companies receive a structured assessment of their own data and, if possible, external sources. This supports the reliability of the evaluations. In addition, materiality analysis is used to identify relevant sustainability aspects from different perspectives. Benchmarking in these areas enables companies to compare their performance with industry standards and strive for targeted improvements.

Double benefits for companies

This standardized procedure makes greenwashing virtually impossible. The solution offers companies two advantages: "The software should be used to check the plausibility and



completeness of their own reports, identify gaps, and make suggestions for closing these gaps – for example, by comparing them with competitors in the same industry," explains Pia Schreynemakers. In addition, "Sustainalyze" will enable companies to evaluate the reports of other companies when selecting suppliers or potential cooperation partners. "In the future, Sustainalyze will thus complement self-assessment with third-party assessment," says the researcher.

The final project phase ended in January 2024. The collaboration with ebm-papst Mulfingen GmbH & Co. provided many insights into industry-relevant sustainability reports and valuable experience in the day-to-day handling of the database. The algorithm was then tested under real conditions and further optimized through use case interviews. "Sustainalyze" will be available for purchase via the Fraunhofer IML's Omnistics AI platform in the course of 2025 (p. 40).

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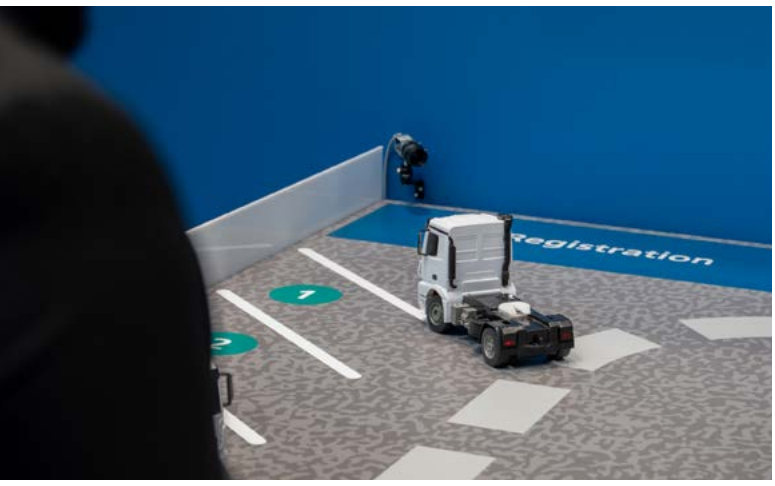
From Challenges to Opportunities:
Evolution of Yard Logistics

The sun rises over a logistics center in Dortmund, where a new working day begins. Trucks come and go as drivers steer their large vehicles to the loading gates. Conveyor belts and forklifts hum in the background. Every day, an enormous logistical effort is carried out at this central transport hub in Germany. Even at night. But despite the seemingly smooth processes, those involved face enormous challenges in yard logistics.

The battle against time

Hundreds of trucks have to be loaded and unloaded every day. Every delay costs money and can throw the entire schedule into disarray. In Germany, more than three billion tons are transported by truck every year, making efficiency at these hubs crucial.

Technical tracking of trucks is often challenging. Inaccurate GPS signals make it difficult to clearly assign trucks to loading gates. The heterogeneous fleet and unknown trucks from subcontractors make it difficult to implement a uniform localization technology. Traditional yard management systems (YMS) are mostly based on target data, which means that deviations are often not detected in time. These shortcomings can lead to costly mistakes and safety risks, such as when a swap body is uncoupled while it is still loaded.



Technological change

The Yard Lens on Edge project was launched to address these challenges. Using state-of-the-art camera technology and artificial intelligence, it aims to enable real-time monitoring of trucks and loading units at logistics yards. Julian Hinxlage, project manager at Fraunhofer IML, explains: "We want to develop a solution that significantly improves the visibility of processes in yard logistics."

A key component is the installation of cameras in the yard. The cameras are strategically positioned to provide complete surveillance of the entire yard area and track the movements of trucks and other objects (e.g., trailers, swap bodies, other yard vehicles) in real time. The so-called multi-view multi-object tracking technology (MV-MOT) enables the simultaneous tracking of several objects from different angles. A further step is the projection of the coordinates onto a 2D map view (mapping), which visualizes the parking spaces.

The digital twin

The project focuses on developing a digital twin of the entire yard. Hinxlage explains: "By continuously collecting real data, we are creating a virtual image of the yard. This gives everyone involved – from truck drivers to yard managers – a comprehensive overview of the status and position of every single object at all times." The system not only offers greater transparency, but also significantly increases efficiency. Delays or incorrect assignments are detected immediately, enabling quick action to be taken.

Image: industrieblick – stock.adobe.com, Fraunhofer IML

The system independently identifies trucks and loading units and tracks their movements in real time. Users can create a customized yard layout via a web platform that can be easily adapted to structural changes.

Advantages of real-time monitoring

The "Yard Lens on Edge" system offers promising advantages: The cameras work accurately and reliably even in difficult lighting conditions. Thanks to markerless detection of trucks and loading units, trucks do not need to be retrofitted with identification features such as 2D codes on the roof.

An outstanding feature is the real-time processing of image and video data directly on the cameras. This not only ensures fast detection and tracking of positions, but also meets important data protection requirements, as only relevant information is processed and stored. On request, events can be archived as video or image material.

A look into the future

The development of Yard Lens on Edge could have far-reaching implications for the entire logistics industry. The system is not only a step toward greater efficiency, but also a significant advance in the digitalization of logistics. The improved visibility and traceability of trucks and loading units optimizes yard operations and enables challenges to be addressed proactively.

Julian Hinxlage is convinced: "With Yard Lens on Edge, we are creating a technology that will play a central role in yard logistics not only today, but also in the future."

The project was funded as part of the "Silicon Economy" initiative by the German Federal Ministry of Digital and Transport (BMDV) and carried out in cooperation with various industry partners. DACHSER Group SE & Co. KG is acting as a pilot partner and enabling the practical implementation of the technology at its logistics center in Dortmund. Once the project is complete, all components will be made available as open source to enable further development and use of the technology in other logistics companies.

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Reuse, Single-Use, **or no Use at all?**

Why sustainable packaging is not a black-and-white issue and what really matters

When it comes to packaging, many people are quick to judge: single-use is bad, reusable is good. Plastic is considered a climate sinner, paper a savior. Biodegradable? Sounds perfect. But anyone who seriously investigates sustainable packaging quickly realizes that the truth is more complicated. Much more complicated.

This is because packaging cannot be evaluated in isolation. Whether it is sustainable depends on numerous factors – from material procurement and transport distances to the reality of disposal. And above all, it depends on how it is used in the overall system. There is no universal solution that is always right. Only individual, often complex decisions – where even well-intentioned approaches can lead astray.

The packaging jungle

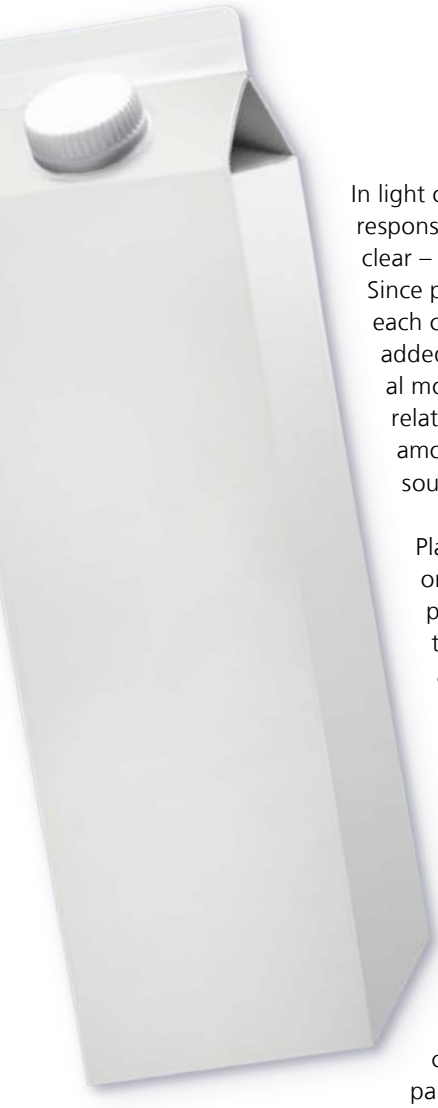
Packaging is both a blessing and a curse. It protects products, extends shelf life, enables global trade – and at the same time generates enormous amounts of waste. According to the German Federal Environment Agency, more than 19 million tons of packaging waste were generated in Germany in 2021. Politicians are responding with regulations such as the EU Packaging and Packaging Waste Regulation (PPWR), which aims to reduce materials, strengthen recycling, and promote reusability. Companies are under pressure to act green without operating in the red. This is because they often lack a differentiated view.

Packaging must not be viewed in isolation from the overall system. What makes sense in one case may be harmful in the next. A disposable cardboard box made from recycled paper that is kept in the recycling loop may be better for the environment than a reusable container that has to be returned and cleaned at great expense – and may break after only a few uses.

Material selection: between myth and molecule

Paper is considered ecologically clean – it comes from renewable raw materials, is easy to recycle and decomposes relatively quickly. But that is only half the truth: paper production is energy- and water-intensive, and fresh fibers are partly sourced from controversial forestry sources. The paper industry is the fifth largest industrial energy consumer worldwide.

Images: dragonstock, George Dolgikh; rdnzl, fotofabrika, by-studio, Himmelssturm – stock.adobe.com



In light of these facts, the urgency of responsible paper use becomes more clear – and recycling more important. Since paper fibers lose quality with each cycle and fresh fibers must be added, recycling is not a perpetual motion machine, but it works relatively well and saves a large amount of water and energy resources in production.

Plastics – especially fossil-based ones – have a reputation for polluting the environment. But they do have advantages: they are lightweight, stable, versatile – and very easy to recycle in pure material streams. But here lies the problem: not all plastic packaging is made of pure material. In addition, additives (auxiliary/additional substances) provide flexibility, UV protection, or sealability – but make recycling difficult. Composite packaging, i.e., material composites made of plastic, paper, and aluminum, also pose major problems for sorting plants.

At first glance, bio-based or biodegradable plastics appear to be the solution. However, many of these materials only degrade under very specific conditions – for example, in special composting plants. In practice, they often end up in the yellow bag. There they cause problems – just like in classic plastic recyclates.

Recycling? Only as good as the system behind it

Recycling only works if the system works. A yogurt cup with a paper sleeve, aluminum lid, and plastic cup sounds well thought out. However, an ideally recyclable cup is useless if everything ends up in the yellow bin or if the cup cannot be recycled because the sorting plant does not recognize the material. Black plastics, for example, are considered problematic because many infrared scanners cannot detect them. Paper sleeves that are not removed or incorrectly placed labels can also cause packaging to be sorted out as contaminants and end up in incineration despite the best of intentions.

One thing is clear: waste disposal infrastructure is crucial. Germany has a relatively good recycling rate compared to other European countries. Nevertheless, large quantities are not recycled but used to generate energy. In other words, they are incinerated. In other countries, the situation is often even worse. Waste exports, inefficient collection systems, and a lack of technology all mean that a product considered exemplary in Germany becomes an environmental burden in southern Italy. Sustainability therefore depends not only on the product, but also on the location.

Disposable or reusable? A question of arithmetic, not a question of faith

The debate is ideologically charged. Reusable is considered noble, disposable is considered trash. But the reality is more nuanced. Reusable packaging – such as sturdy plastic containers or glass bottles – causes significantly more CO_2 emissions and resource consumption in production than disposable packaging. It only makes eco-

logical sense if it is used often enough – the so-called break-even point.

How many cycles are necessary depends heavily on the system in question. If the container is transported regionally and returned efficiently, for example, its ecological footprint can quickly be relativized in comparison to disposable packaging. However, if hundreds of kilometers have to be covered, the advantage is quickly lost. Even more serious is breakage or loss. If a reusable container is lost or broken after just a few cycles, the initial investment was a waste from an ecological point of view.

A practical example: Reusable fruit crates have become established in food wholesaling over many years – but only because they are systematically returned and cleaned centrally. If there is no return system or if there are high losses, disposable packaging is often more resource-efficient. This shows that reusability only works with logistics behind it.

Product protection: the often forgotten core function

One aspect that is often overlooked in the debate is the protection of the packaged product. Packaging is not an end in itself – it is intended to prevent goods from being damaged or destroyed. After all, the ecological damage caused by replacing or disposing of a damaged laptop, spoiled fruit, or a broken bottle is usually many times greater than the ecological footprint of the product's packaging.

If the packaging is too light or unstable, the risk of damage during transport increases. Supposedly "sustainable" packaging can thus become a boomerang. Sustainability does not automatically mean reduction – it means weighing up the options.

Life Cycle Assessment: Looking at the big picture

Only life cycle assessment (LCA) provides truly reliable answers. It considers all phases of a product – from raw material extraction to production and use to disposal. Numerous parameters are taken into account, including CO_2 emissions, water consumption, land use, and energy requirements. This is the only way to assess whether packaging is truly sustainable – or just appears to be.

LCAs show that simple answers are usually wrong. Single-use can be better than reusable. Paper can perform worse than plastic. A heavy glass bottle can cause more CO_2 than a recycled PET bottle – if it is transported over long distances.

PPWR, green claims, and digital control

The new EU Packaging Regulation (PPWR) is intended to provide greater clarity – and more binding commitments. In future, packaging is to be standardized for recycling, reuse is to be promoted more strongly, and certain materials are to be phased out. The intention is good – but implementation carries risks.

Among other things, there is criticism of the planned fee modulation: those who recycle better should pay less. But what is "better" is often a matter of interpretation. The danger is that packaging that is recyclable on paper but not in reality – so-called green claiming – will become commonplace. Companies adorn themselves with supposed sustainability that is practically impossible to deliver.

A promising approach is the digital traceability of packaging – for example, by scanning QR codes or digital watermarks that provide information about origin, material mix, and recycling route. However, there is still a lack of uniform standards – and acceptance.

Humans as the final authority

And then there are humans. Even the best system is useless if consumers don't play along. Anyone who doesn't separate the paper sleeve from the yogurt cup, uses the wrong bin, or throws compostable items in the yellow bag is unintentionally sabotaging the system. Communication, education, and "design for recycling" are therefore crucial. But even clear symbols are only of limited help if there is no willingness to implement them.

Conclusion: Less dogma – more context

Sustainable packaging is not a question of "good" or "bad." It is a systemic challenge that affects all levels: materials, logistics, infrastructure, user behavior, and life cycle. What makes ecological sense depends on the individual case – not on the image of the material. Anyone who wants to design truly sustainable packaging must be prepared to think in a differentiated way – and let go of simple truths. Because sustainable packaging is not a standard. It is custom work.

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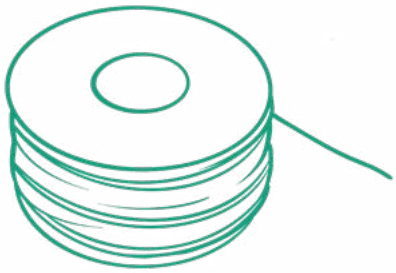
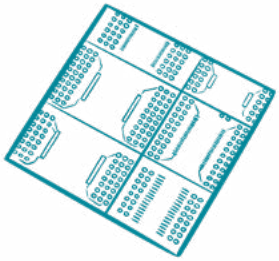
The packaging portfolio of Fraunhofer IML

Fraunhofer IML offers comprehensive services to support companies in developing and optimizing their packaging strategy – in an ecologically and economically sound manner.

The institute's services include:

- **Life Cycle Assessment (LCA):**
  The researchers use detailed life cycle assessments to determine the environmental impact of packaging. This allows them to identify specific emission drivers and make informed decisions to increase the sustainability of packaging systems.
- **Packaging assessment:**
  The researchers analyze packaging and load carriers according to economic, technical, and ecological criteria in order to identify optimization potential and increase efficiency.
- **Customized packaging planning:**
  The institute provides support in the customized planning and design of packaging systems with a view to the entire life cycle – from procurement to disposal. This also includes the selection of disposable and reusable systems to ensure resource-efficient packaging use.
- **Packaging testing:**
  In the Fraunhofer IML's specialized packaging testing laboratory, experts test the resilience and suitability of packaging made from various materials under realistic conditions. Using static, dynamic, and climatic tests, they ensure that the packaging meets all logistics requirements.





Resilience Reloaded

How can European supply chains become more resilient, sustainable and future proof? The EU project ReSChape provides answers – with in-depth analyses, concrete recommendations for action and practical impulses for business and politics.

Global supply chains are under pressure. Between geopolitical tensions, regulatory hurdles and digital change, well-established processes are increasingly faltering. But how can a stable, resilient network of goods and information flows be established under these conditions? The European research project ReSChape provides answers. Together with international partners, Fraunhofer IML is developing recommendations and strategies to make Europe's supply chains more resilient, sustainable and future viable. Dr. Markus Witthaut, Senior Scientist at the institute, gives an insight into the project's findings and perspectives – and shows why strategic thinking is more important today than ever.

A project between science and politics

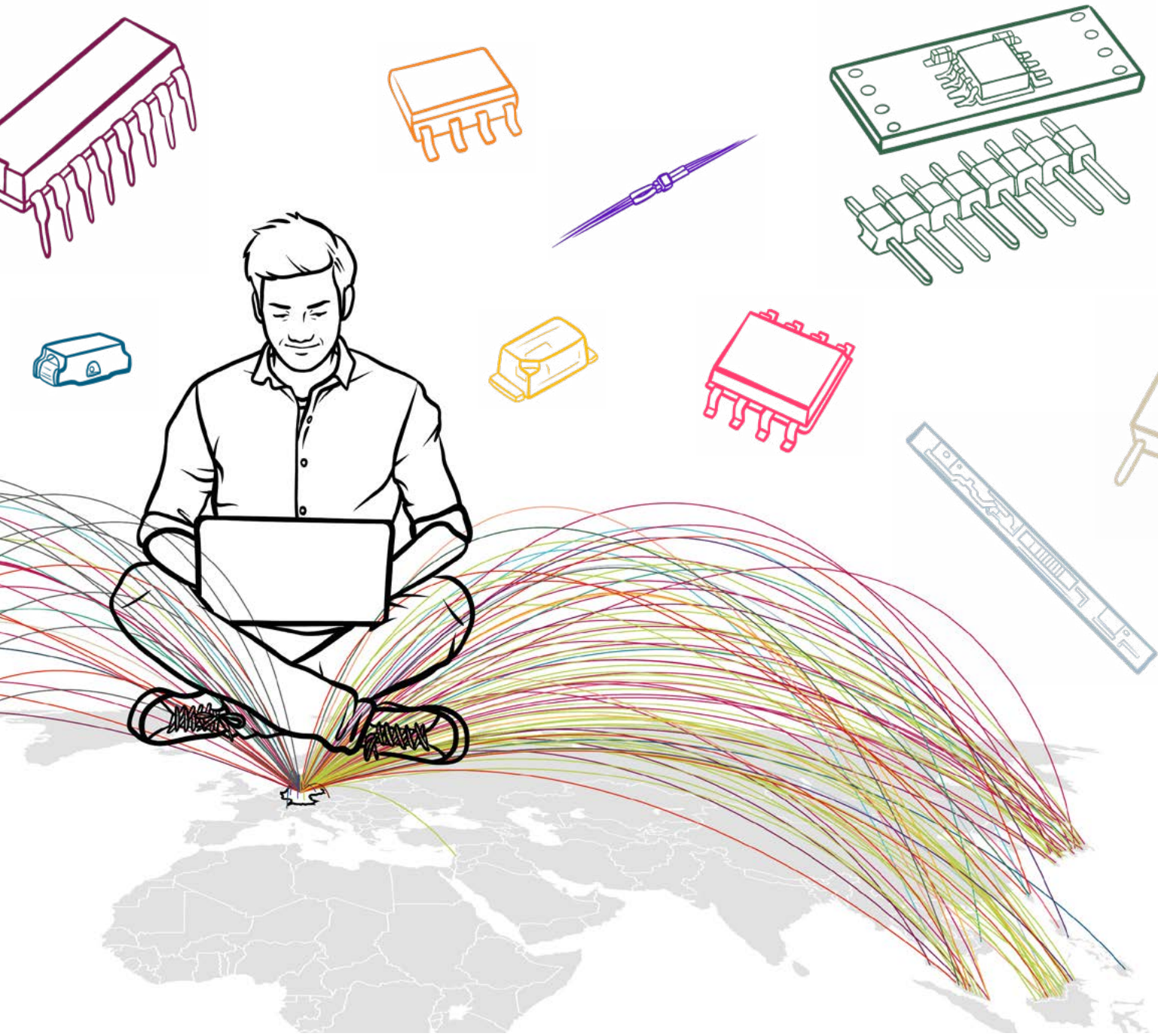
ReSChape operates at the interface between applied research and policy recommendations. "We are basically a kind of think tank for resilient supply chains," explains Dr. Witthaut. "What we do here is not just academic – it is deliberately aimed at companies, but also at political policy makers." This is unusual for a traditional research project, but necessary, as many of the challenges are not just operational, but structural, systemic and often even geopolitical.

> **"We are basically a kind of think tank for resilient supply chains"**
>
> Dr.-Ing. Markus Witthaut

Together with partners from Spain, Italy, Portugal, the Netherlands, Germany and the UK, Fraunhofer IML has spent two years analyzing where the Achilles' heels of European supply chains lie. Five central areas of risk emerged that – regardless of industry or company size – are recurring stumbling blocks.

Disruption as the normal state of affairs

The first of these challenges is increasing supply insecurity. Conflicts, natural disasters or simply changing economic conditions mean that the availability of materials is becoming increasingly difficult to plan. "We saw this particularly clearly during the coronavirus pandemic – but even now, for example when container ships have to avoid the Red Sea or tariffs in the USA are adjusted at short notice, it is clear that planning reliability is now the exception," says Witthaut.



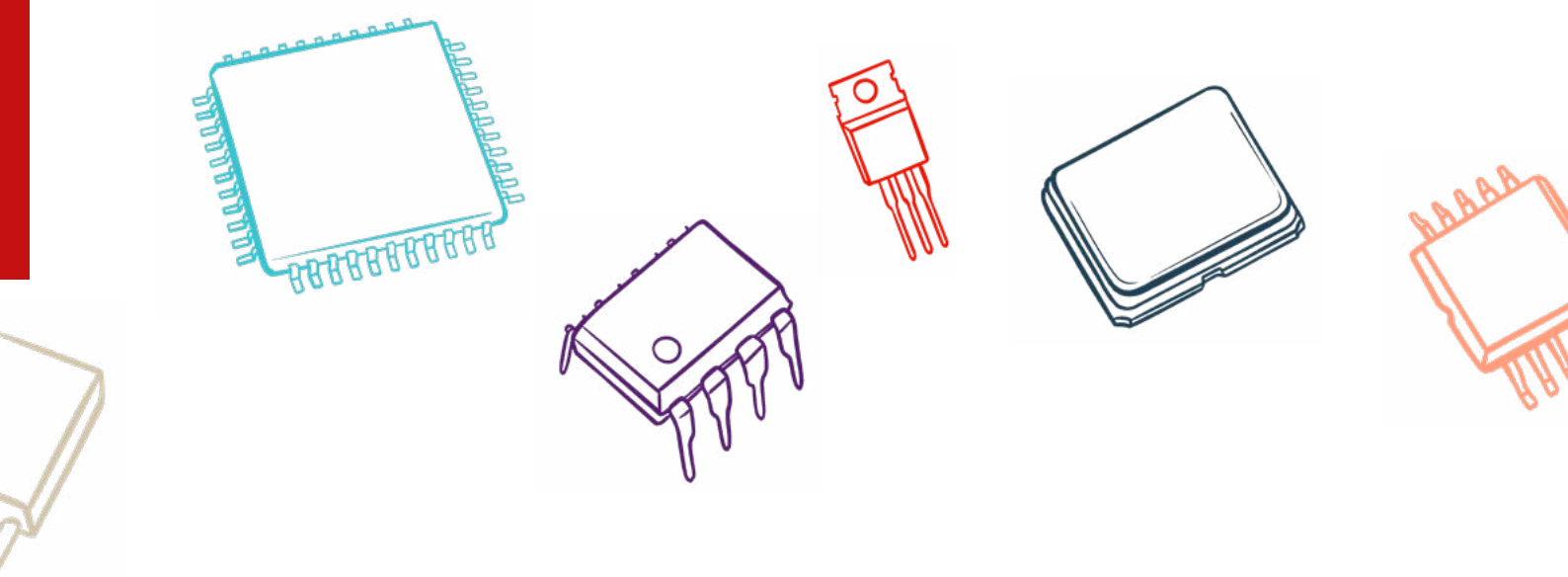
Behind many of our everyday objects lies a global supply chain network: for example behind all the components of a laptop.

At the same time, it is becoming more difficult for companies to predict future demand. Digitalization, changing consumer behavior, demographic changes and technological leaps mean that traditional sales forecasts often come to nothing. "This is not just to do with customer demand – it is changing entire business models. Anyone who makes a mistake when forecasting demand will have to pay dearly for it."

Digital tools as an opportunity and a challenge

Great hopes are pinned on digitalization. Artificial intelligence, automation and data-driven decisions all hold enormous potential. At the same time, it raises new questions: "What happens to activities that people used to do? What do companies and their employees need to know for AI to deliver correct and comprehensible results? What can AI do and what can't it do – today and in the future?" asks Witthaut. Fraunhofer IML sees great opportunities here, but also warns against exaggerated expectations.

Another factor that threatens the resilience of supply chains is the lack of qualified specialists. "Our education system is not designed for permanent change," says Witthaut. "Lifelong learning is a buzzword – but the reality is often different." Particularly in industries such as logistics, the pressure to innovate is enormous, while at the same time there is often a lack of suitable vocational training opportunities or strategies for passing on knowledge within the company.



Between regulation and responsibility

The field of regulation proved to be particularly complex during the project. Laws such as the German Supply Chain Duty of Care Act (LkSG) or the EU-wide Carbon Border Adjustment Mechanism (CBAM) present companies with enormous challenges. "The intention is absolutely understandable – those who consume in Europe should be sure that products have been manufactured under fair and environmentally friendly conditions. But in practice, there is often a lack of clarity," explains Witthaut.

What exactly does it mean when a company must prove that there is no child labor in its supply chain? How does a risk-based audit in multi-level, global networks work? And how can such processes be implemented for SMEs that do not have their own legal departments or compliance teams? "Practical tools and clear guidelines for action are urgently needed here," emphasizes the research scientist. The EU Omnibus Initiative, which aims to simplify companies' reporting obligations, is a first step in this direction. However, such efforts need to be stepped up considerably.

Impetus for companies and politics

ReSChape not only provides analyses, but also recommendations. For companies, the project offers a structured framework with which existing supply networks can be examined for weak points and strategy development. This is not about academic ideal models, but about concrete strategies with which risks can be mitigated and opportunities exploited.

Witthaut sees the work of Fraunhofer IML as a bridging function: "We try to meet companies where they are. Together, we develop design workshops, evaluate existing structures and help to develop future scenarios." The project emphasizes not only risks, but also potential – for example through targeted nearshoring, an improved warehouse strategy or technological partnerships in Europe.

However, politicians also have a responsibility. After all, many framework conditions for resilient supply chains cannot be solved at company level. ReSChape therefore also sees itself as a driving force for the EU Commission and national legislators, for example by participating in consultations or by providing scientifically sound recommendations for simplifying and harmonizing regulatory requirements and EU policies.

Stability needs structure

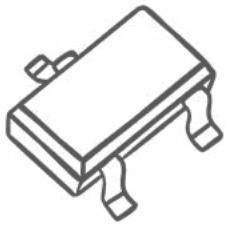
A central result of the project is the realization that resilience is not a state, but a process. And this process needs structure, clarity and strategic thinking. "We are seeing a growing awareness of the fragility of our economic systems in Europe – but also a willingness to learn from this," says Witthaut.

> **"We are seeing a growing awareness of the fragility of our economic systems in Europe – but also a willingness to learn from this"**
>
> Dr.-Ing. Markus Witthaut

It is true that not every industry faces the same challenges and not every company needs the same solutions. However, the five key issues identified – supply uncertainty, forecasting uncertainty, digitalization, qualification and regulation – provide a framework for organizations to align their further development with.

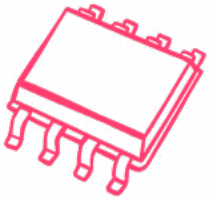
ReSChape as a starting point for transformation

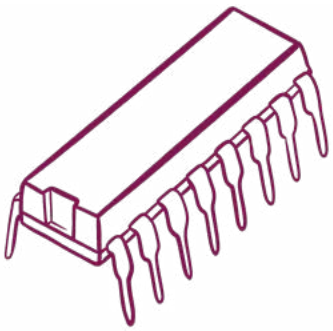
For Fraunhofer IML, the project is not the end, but the starting point. "We have the knowledge, we have the tools – now it's about putting them into practice," emphasizes Witthaut. The first companies have already sought advice and further pilot projects are being planned.



The research scientist sees great potential, particularly in combination with digital offerings – such as the Open Logistics Foundation: "This non-profit status organization, which offers companies a neutral platform for the joint development of open-source software, can help to implement operational resilience – and ReSChape provides the strategic basis for this. One complements the other perfectly."

In a world that is changing ever faster, the ability to adapt is becoming a decisive competitive factor. ReSChape shows that resilience does not have to be an abstract concept – it can be shaped in concrete terms. For companies, for politics – and for future viability of logistics in Europe.





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ReSChape

The EU project ReSChape (https://reschape.eu/) is dedicated to the question of how European supply chains can be made more resilient, sustainable and future proof. The project analyzes social, economic and environmental changes in global value networks and develops strategies for robust supply chain management.

A central aspect of ReSChape is the identification of risks and challenges arising from current trends. Based on these findings, well-founded recommendations for action are developed for companies and political decision-makers. The project is supported by a European consortium including Fraunhofer IML, Eindhoven University of Technology and Aston University.

In addition to developing new supply chain models, ReSChape is also investigating the role of digitalization as a means of promoting social inclusion and adapting to economic and environmental changes. Various European industries such as fashion, automotive, medical engineering and mechanical engineering are being analyzed to develop industry-specific solutions.

The project runs until September 2025 and is funded under the Horizon Europe program. The aim is to develop innovative tools to monitor and evaluate trade patterns and provide mechanisms to analyze disruptions in global value chains.

to the website

Digital Helpers in Times of Need

Flowers in their hair, glitter on their faces, net tops, bare skin. In July 2010, thousands make their way to Duisburg to party, rave and dance at the Love Parade. On the way to the site, the revelers have to pass through a narrow tunnel. At the same time, others are making their way back. The tunnel becomes a bottleneck. The rush is huge, it is narrow, panic breaks out. While the emergency services on site try to get the situation under control, rescue workers are alerted to attend to the injured.

Crises such as the mass panic at the Love Parade in Duisburg, the major fire in Grunewald or the flooding in the Ahr valley have one thing in common: they involve many rescue and emergency services and consume a lot of materials. Materials such as bandages, pain medication or other items may be in short supply.

In order to be able to act more efficiently and effectively in such and other crisis situations, the interdisciplinary research project "ResKriVer – Communication and Information Platform for Resilient Crisis-Relevant Supply Networks" was launched, which was funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) over three years. As part of this project, Fraunhofer IML has developed two applications based on artificial intelligence (AI) in collaboration with the Berlin fire department that can support the decision-making processes of the Fraunhofer Crisis Team.

Support – without jeopardizing regular operations

For authorities and organizations with security tasks (BOS), such as the fire department, rescue services, aid organizations and the police, such crisis situations are a great burden and challenge. They are responsible for ensuring that protective equipment, spare parts for emergency vehicles and medical equipment are and remain available. If materials become scarce in the affected areas, BOS in other regions nearby are asked whether they can deliver relief supplies without jeopardizing their own regular operations.

The service developed by Fraunhofer IML and the Berlin Fire Department for "Maintaining regular operations when delivering relief supplies in global crises (ReCheck)" is a simple, web-based application that can support the requested BOS in making a decision. When an article such as "compress" is entered, the OTD NETWORK supply chain simulation tool from Fraunhofer IML carries out a simulation run. It takes stock levels, historical consumption data and ordering policies into account. The results of the simulation are displayed as traffic lights in a dashboard , which provides an immediate overview and shows which items can be delivered without restricting regular operations.

Resilient – even when global supply chains are disrupted

The coronavirus pandemic has dramatically demonstrated that global problems can also occur with the availability of materials such as masks or antibiotics. But local events, such as the blockade of the Suez Canal, also have a major impact on global supply chains and can therefore hit companies and BOS hard. In order to be able to react to such events at an early stage and ideally even avoid supply bottlenecks altogether, the researchers developed the "Evaluation of Security of Supply (EvaVe)" service. The application works in a similar way to "ReCheck": it is a web-based application that simulates the disruptions entered, such as a sea route blockage, and visualizes the possible effects with the help of a traffic light in the dashboard. In the next step, recommendations for action can also be generated. Coupling the

simulation tool with AI makes it possible to run through a large number of possible solutions in the shortest possible time and thus see which approaches would bring about an improvement and what costs would be incurred.

Digitalization – for better crisis management

Reliable decision support is essential, especially in crisis situations. "ReCheck" and "EvaVe" are two services that can forecast the effects of supply bottlenecks and collect, generate and communicate specific information. However, both services need a solid data basis, such as stock levels, consumption data, ordering policies and supply chain data, in order to generate reliable simulations. A survey conducted by the Berlin fire department among members of BOS revealed that only around a third of the organizations surveyed use digitalized inventory management systems. In terms of ordering and procurement, only around ten percent of the participating BOS were using these systems, meaning that widespread use is currently hardly conceivable. However, the digitalization of these systems could enable crisis situations to be managed much more efficiently and effectively in the future, thus minimizing the consequences.

Solid – also for companies

Fraunhofer IML is currently working on a service that focuses on the resilience of companies' supply chains. In the "ResiOpt" project, the researchers developed the Supply Chain Risk Assessment, which aims to increase resilience in supply chains. This involves analyzing supply networks and then generating a catalog of measures that can effectively minimize risks caused by disruptions in the supply chain.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

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A Project With **Vision**

Automation, transparency, trust: The SKALA project illustrates that artificial intelligence and blockchain technology are becoming real game changers for logistics. Scalable open-source solutions are connecting entire value creation networks, which can benefit small and medium-sized companies in particular. Researchers at Fraunhofer IML explain exactly how this works.

Numerous researchers at Fraunhofer IML are currently working on fundamentally redesigning the logistics of tomorrow. One central project is SKALA: a research project funded by the German Federal Ministry for Digitalization and Government Modernization (BMDS) that combines artificial intelligence (AI) and blockchain technology to create an intelligent ecosystem. The aim is to make production and logistics processes more efficient, transparent and robust across company boundaries.

"We see the combination of AI and blockchain not only as a technological potential, but also as a structural answer to many of the challenges facing logistics today," says Dr. Maximilian Austerjost, project manager at Fraunhofer IML. SKALA does not stand for an isolated solution, but for a modular, open construction kit that can be adapted to the needs of a wide variety of companies.

From vision to open-source platform

SKALA pursues a consistently open approach: all software modules, AI models, smart contracts and interfaces developed in the project are to be published as open source. "We want to pave the way for real innovation – especially for small and medium-sized companies that could hardly afford such developments on their own," emphasizes Austerjost. The project is therefore not only aimed at technical excellence, but also at a broad transfer into practice.

The focus here is on the idea of technology convergence: the blockchain provides trust in the data as a tamper-proof infrastructure – and the AI ensures its intelligent evaluation, validation and use. This creates a digital bridge between players, systems and processes that previously had difficulty communicating with each other.

According to Maximilian Austerjost, building this bridge is essential in order to overcome existing system boundaries. "Many companies work with isolated IT solutions. We show how an open, interoperable network can be created that offers real added value – both technologically and economically."

> **"Many companies work with isolated IT solutions. We show how an open, interoperable network can be created that offers real added value – both technologically and economically."**
>
> Dr. Maximilian Austerjost

GreenComplAI: Automating Sustainability

One concrete example of this connection is GreenComplAI, a solution developed as part of SKALA for the continuous sustainability audit of supply chains. The system combines, for example, digital product passports, automated data coll-

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ection and AI-supported plausibility analyses into a tool that helps companies to ensure their ESG and CSRD compliance as well as their resilience in general. In the future, the tool can also be used around risk management.

"GreenComplAI can assess in real time whether predefined requirements are being met and thus directly supports the sustainable transformation of companies and their supply chains," explains Austerjost. The highlight: the necessary evidence is generated automatically, inspection processes become more transparent and less error prone. This not only saves time and money, but also creates trust – both internally and externally.

Transparent, digital verification management is becoming a strategic success factor, especially against the backdrop of stricter legal requirements such as the EU taxonomy. GreenComplAI provides the right infrastructure for this – flexible, scalable and future-proof.

SiMBA: Dynamic prices, smart decisions

A second module in the SKALA portfolio is SiMBA – an intelligent system for dynamic pricing. It continuously analyzes capacities, market conditions and operational workloads and automatically adjusts prices. "SiMBA enables companies to react faster and more precisely to changes – a real efficiency driver in volatile markets," says Austerjost.

Individually definable regulations and integrated invoicing functions cover the entire process from quotation to payment. This not only allows sales potential to be better exploited, but also enables operational resources to be managed in a more targeted manner. Austerjost emphasizes: "SiMBA allows us to make efficient use of market dynamics and at the same time better align operational planning with short-term changes. This is an enormous competitive advantage in today's world."

The system is particularly interesting for logistics service providers whose margins are under pressure. "With SiMBA, companies can not only operate more efficiently, but also develop new pricing models – such as capacity-dependent tariffs or dynamic remuneration systems."

InstaSCAN: digitalization at the touch of a button

SKALA is also focusing on document management. InstaSCAN is an AI-supported system that automatically digitizes paper-based documents such as waybills, extracts relevant information and transfers it directly to IT systems. The difference to traditional OCR solutions: InstaSCAN recognizes content contextually and checks its plausibility – an important prerequisite for automated follow-up processes.

"38 percent of companies still work with paper processes. This is not only inefficient, but also risky," says Austerjost. InstaSCAN is designed to close this gap – without media disruptions, without manual post-processing and without integration hurdles.

The system also enables complete traceability and secure archiving of relevant documents – key requirements for audits, certifications and compliance checks. InstaSCAN is therefore a prime example of applied research into AI, says Austerjost.

Digital identities and trust in the supply chain

The central basis for the applications of SKALA are so-called digital identities – i.e. unique, verifiable characteristics of products and actors in the supply chain. These identities make it possible to exchange information securely and traceably. Blockchain technology plays a key role here because it acts as a trustworthy register.

"Trust in data is essential if I want to digitize business processes," explains Austerjost. "Only if I know for sure that a data record has not been manipulated, I can trust it." The combination of AI-based validation and blockchain-supported storage creates this basis of trust at a technical level – and thus opens up completely new possibilities for automation and collaboration.

This technology is a real game changer, especially for complex supply chains with many partners. It not only enables greater transparency, but also greater resilience to disruptions because information flows faster and more reliable.

The building block for digital change

SKALA is more than the sum of its parts. All solutions follow a modular principle and can be combined with each other. They can also be integrated into existing IT infrastructures via standardized interfaces – another important aspect for SMEs. Numerous demonstrators and use cases are to be published by the end of 2025 to make it easier for companies to get started.

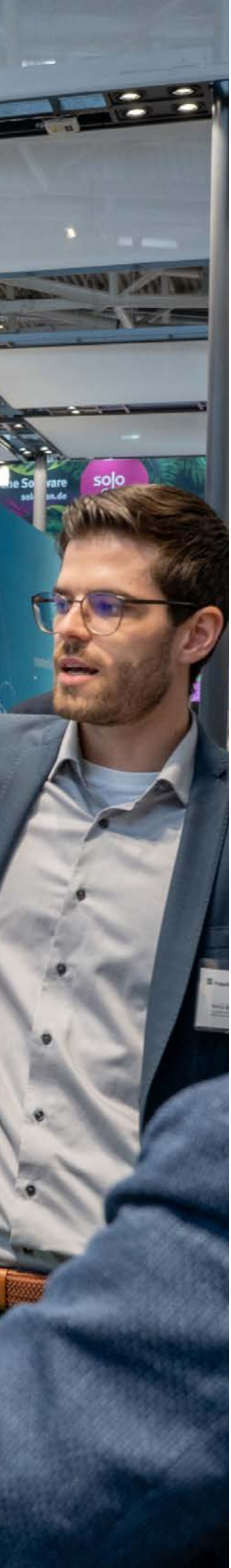
"We don't want this to be an ivory tower project," emphasizes Austerjost. "Our goal is to provide concrete answers – to real problems in real processes." This is precisely why the open-source approach is so crucial: it enables exchange, further development and genuine dissemination on the market.

In addition to the modules already developed, the project team is currently working on further solutions – such as the automated evaluation of sustainability indicators or the integration of digital twins into logistics networks. Development always takes place in a practical manner and in close cooperation with companies from various sectors.

A project with political backing

SKALA is also attracting interest from politicians. At the presentation of the funding decision, Oliver Luksic, former parliamentary state secretary at the BMDV, emphasized the importance of the project: "The combination of AI and blockchain holds enormous potential for optimizing proces-

Federal Ministry
for Digitalization and
Government Modernization



ses, increasing transparency and significantly boosting efficiency in supply chains."

SKALA is an ideal fit for the German federal government's digital strategy and could make an important contribution to strengthening Germany as a logistics location. The fact that the solutions are openly accessible and thus enable smaller companies in particular to access key technologies is viewed particularly positively.

New business models through technology convergence

Another key objective of SKALA is to enable new business models by combining different technologies. "Many companies today don't even know what is already technically possible – let alone how new value creation models can emerge from this," explains Austerjost. SKALA aims to build precisely this bridge: through demonstrators, consulting services and open-source modules that invite experimentation.

To this end, Fraunhofer IML is working closely with its project partners, including the Fraunhofer Institute for Software and Systems Engineering ISST and two chairs at TU Dortmund University. Together, they are working on cross-sectional technologies that can be flexibly adapted to different sectors – from the manufacturing industry and retail to highly regulated areas such as healthcare.

Networking, scalability and practical relevance

What makes SKALA so special is its consistent focus on practicability. The architecture developed is scalable, the solutions adaptable and the software modules interoperable. Companies can test individual components, implement them step by step and adapt them as required. This not only reduces technical risks, but also increases acceptance among the workforces. Austerjost: "These are de facto tools that solve problems in completely different places but in the same way. Dynamic pricing, for example, can be used for pallet pooling as well as for pricing in supply chains. And GreenComplAI can check sustainability data as well as other suppliers, while InstaSCAN can be used to analyze bills of lading, pallet bills and chemical certificates. That's what makes the whole thing so exciting."

> **"Technology is only effective if people can understand and use it"**
>
> Dr. Maximilian Austerjost

In addition, SKALA offers a unique learning platform: workshops, webinars and training materials accompany the transfer of knowledge and ensure that the solutions developed also reach a wider audience. "Technology is only effective if people can understand and use it," says Austerjost, explaining the reasons why Fraunhofer IML also offers corresponding support services.

Conclusion: Digitalization with substance and vision

With SKALA, Fraunhofer IML is demonstrating how future technologies such as AI and blockchain can be put to practical use. The project represents a new approach: not dogmatic, not abstract – but close to reality, close to the needs of companies.

Austerjost sums it up: "We are not developing solutions for the drawer here. Our aim is to enable companies to really work with them – and to make them more successful, more sustainable and more independent." The SKALA philosophy encourages companies to see digitalization not as a burden, but as an opportunity – for logistics that is not only more efficient, but also fairer and more resilient.

to the video

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Resilience – **A Smart Move**

Unpredictability is increasingly becoming the new political norm. This poses enormous risks for the market and the economy. In times like these, companies of all industries must be particularly well prepared for crises, according to researchers at Fraunhofer IML. While tariffs, disasters, and wars are driving the next crisis forward, technological innovations continue to evolve. Researchers offer recommendations on how companies can prepare themselves.

It is quiet in the production hall – deafeningly quiet, you might say. Every minute that no car rolls off the assembly line, no employee assembles parts, no sheet metal is welded, costs money. And all because of a few components, small components – just a few nanometers in size. The chip crisis is sending shockwaves through the automotive industry: Reuters reported back in March 2021 that VW was unable to produce around 100,000 vehicles due to the chip shortage. As Springer Professional noted at the beginning of January 2022, all car manufacturers have had to repeatedly halt production since the beginning of 2021 due to the semiconductor scarcity. An estimate available at the time from Springer Professional assumed that automobile manufacturers would be unable to produce vehicles worth 210 billion US dollars due to the chip shortage.

This decline is also affecting automotive suppliers, who are left with unsold parts, while other industries such as the game console industry are also reeling. At the time, geopolitical tensions between the US and China and the resulting tariffs that set the crisis in motion played their part as well. The companies affected agree: no one could have foreseen the extent of the crisis.

to the whitepaper

Image: Jezper – stock.adobe.com

Companies need to constantly adapt to new conditions.

"In an acute crisis, however, it's not about why we didn't see it coming," says Tobias Jornitz, research associate at Fraunhofer IML. "It's much more important to act immediately and develop stronger resilience skills once the current crisis has been overcome!" As head of the Fraunhofer Resilience Community, he is researching how companies can respond better to crises and thus be more resilient in the future. For the researchers at Fraunhofer IML, constantly adapting to new conditions and withstanding any unforeseeable crises and conflicts is what makes a resilient company. They emphasize how important it is for companies to strategically address their own crisis resilience – because the next crisis will not be long in coming, as current events in 2025 alone underscore. In fact, it is already here, coupled with a great deal of unpredictability.

Geopolitical tensions were just as much to blame for the chip crisis as the sudden surge in demand for cars shortly after the pandemic and natural disasters near several chip factories. The chip crisis is unique in that it combines many key challenges and megatrends that are likely to cause even more crises in the coming years.

In order to master these challenges with confidence, the researchers argue that it is essential for companies not only to return to their previous state along their value creation network after the crisis. "Adapting and transforming the supply chain to the new, changed situation after the crisis is just as important," emphasizes Tobias Jonitz. To do this, senior managers in companies must identify where their supply chain is most vulnerable and what factors are most likely to affect its stability, however minor they may seem. According to the resilience expert, it is often worthwhile to look beyond the boundaries of one's own company.

Working on your own resilience

The earlier companies identify risks alongside their supply chains and within their internal organization, the better they can prepare for crises. What sounds logical is not always a given. Often, communication between the parties involved leaves much to be desired. "To prevent supply chain disruptions, there needs to be more collaboration between the parties involved and the greatest possible openness," says Jornitz. Close cooperation and sufficient transparency between suppliers are central to smooth operations along the supply chain. According to Fraunhofer IML, those who want to master crises with confidence must continuously work on their own resilience. Tobias Jornitz: "Developing resilience is not a one-time activity, but a continuous process that requires the support of top management!"

Tips, tricks, and recommendations on how companies can become more resilient and transform their value creation networks are provided by researchers at Fraunhofer IML in the white paper "Resilience of Value Creation Networks – Systematically Tapping into the Success Factor", which has been published in the series "Future Challenges in Logistics and Supply Chain Management."

We have briefly summarized eight key recommendations here:

1. **Determine resilience requirements**
   Companies must identify the factors that influence their supply chain and where it is particularly vulnerable.
2. **Act collaboratively**
   All players in the supply chain must work together holistically to counteract disruptions and prevent downtime.
3. **Promote openness**
   For proactive risk management, players throughout the value chain should be more transparent and open.
4. **Use digital technologies**
   Digital methods can dramatically expand the scope of action available to companies.
5. **Continuously adapt dynamically**
   In order to remain resilient in the future, stakeholders must constantly adapt to new environmental conditions and evaluate and adjust the current situation as necessary.
6. **Integrate people**
   The connection of people with digital systems and smart machines is essential. It is a central component of supply chain transformation. Appropriate continuing education is needed to increase the necessary resilience.
7. **Build a culture of resilience**
   People still make the decisions in companies, they must see resilience as their responsibility. Current business models and organizational culture must be questioned and adapted by management.
8. **Preserve and apply knowledge**
   To create a suitable resilience strategy, stakeholders must gather, utilize their knowledge from past crises and use it to develop a strategy.

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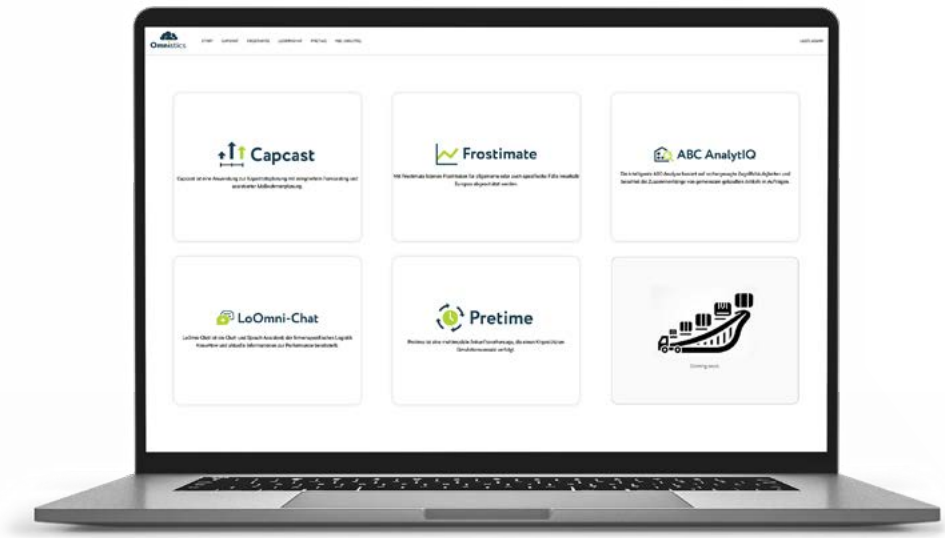
Faster, Cheaper, Smarter:

Omnistics Makes AI Suitable for Mass Use

Image: Sergey Gerasimov – stock.adobe.com

High order volumes, growing complexity in global supply chains, volatile markets, and the ongoing shortage of specialists are presenting logistics companies with a wide variety of challenges. Increasing demands for transparency, delivery reliability, and efficiency are adding to the pressure. This often puts small and medium-sized enterprises (SMEs) in particular under severe strain. How can they manage complex processes in the supply chain when resources are scarce, cost pressure is high, and the flood of data is difficult to keep track of? This is where the Fraunhofer IML's "Omnistics" platform comes in. The modular AI ecosystem was developed specifically for the needs of logistics companies.

With "Omnistics", the Dortmund-based researchers want to give freight forwarding companies without extensive IT infrastructure access to AI technologies. The platform supports the optimization of logistics processes such as shipment volume forecasts, route planning, dispatching, and data analysis. The goal is to make processes more efficient and knowledge more accessible without high initial investments. For companies that struggle with complex supply chains and tight margins on a daily basis, AI can be a decisive lever for streamlining processes and ensuring competitiveness. "Companies must set the course now to benefit from more accurate forecasts, lower costs, and higher customer satisfaction in the long term – and thus maintain their position in a highly competitive market," explains Martin Friedrich from Fraunhofer IML in Dortmund.



Maximum flexibility and control

While large logistics service providers are already making targeted use of AI technologies, for example for route optimization, shipment volume forecasting, or automation in warehouse logistics, SMEs are still more cautious in this area. There are many reasons for this: a lack of internal IT resources, insufficient data, or a lack of expertise to reliably assess the benefits of specific AI applications. The integration into existing systems and long-term scalability are also causes for concern. Fraunhofer IML aims to alleviate these fears with its practical, modular AI solution. With "Omnistics," processes can be improved step by step, workflows stabilized, and existing structures relieved. Small, modular AI tools allow SMEs to gain initial experience in working with AI and use those tools that directly address their challenges. "The goal of 'Omnistics' is not to use AI everywhere just to say that it is AI-based. We see the technology as a tool for solving specific problems in logistics, especially for medium-sized companies," emphasizes Prof. Michael Henke, Institute Director at Fraunhofer IML.

> **"The goal of 'Omnistics' is not to use AI everywhere just to say that it is AI-based. We see the technology as a tool for solving specific problems in logistics, especially for medium-sized companies"**
>
> Prof. Michael Henke

The platform offers barrier-free access to artificial intelligence and integrates various data sources, including internal systems such as TMS, WMS, ERP, and CRM, via open interfaces. Partner data from suppliers and customers as well as public data such as traffic information and weather data can also be integrated. This comprehensive database allows the platform to be hosted entirely on your own hardware – for maximum flexibility and control.

Complex tasks require precise assessments – six tools that provide valuable support

"Omnistics" improves the entire supply chain – from planning to operational implementation: One of the biggest challenges for logistics providers is the uncertain planning basis. Seasonal fluctuations or sudden peaks in orders make it difficult to reliably manage staff and vehicles. The "Capcast" module forecasts shipment volumes based on historical volume data and takes external factors such as economic developments in relevant industries into account. This enables informed decisions to be made and bottlenecks to be identified at an early stage.

In warehouses, there is often uncertainty about item turnover and transit times. Here, the "ABCAnalytiq" module supports the analysis of item and order data to optimize storage and order picking.

Precise knowledge of when freight will arrive is also immensely important: "Pretime" uses AI to accurately predict truck arrival times, ensuring proactive, smooth process control in logistics. The tool considers transportation and weather data as well as the route to optimally plan tours and minimize waiting times. Real-time information enables better resource utilization – not only on the road and at the transshipment point, but along the entire supply chain.

With "Frostimate", transport costs can be realistically forecast based on specific routes and current market data. This creates transparency in calculations and market comparisons. The system continuously learns and adapts to the specific pricing logic of the company.

Often, the cargo space in a vehicle is not fully utilized. There could be room for more packages. The "CargoSight" module uses cameras to detect free cargo space in real time and suggests how vehicles can be packed more efficiently. This improves capacity utilization before departure and optimizes route planning in the long term.

Image: guteksk7 – stock.adobe.com, Fraunhofer IML

Whether as support for new employees, for internal knowledge sharing or for process optimization, the chat assistant "LoOmni-Chat", which is based on company-specific knowledge and data, provides employees with support in their day-to-day work. The Chat GPT for logistics can answer operational and administrative questions about processes, customers, prices, orders, and much more in real time. This means employees have fewer queries, are trained more quickly and no longer have to manually search in manuals. The chatbot can be individually trained in the language, processes and data of the respective company in order to improve knowledge transfer. The system is available around the clock and continuously learning.

"Our applications are so easy to use and so useful that even employees who are still skeptical about artificial intelligence are won over"

Martin Friedrich

"Our applications are so easy to use and so useful that even employees who are still skeptical about artificial intelligence are won over," emphasizes Martin Friedrich. He is convinced that reservations will disappear as soon as, for example, the answer to the question "How much does it cost to ship three pallets from Frankfurt to Sicily in May?" appears on the screen in a matter of seconds – a search that would otherwise take a lot of time.

AI by subscription – including support

With a subscription model, companies can test and use only the tools they really need. The "AI subscription" and its individual tools can be used independently of each other and be combined individually. They can be adapted to the requirements of any medium-sized company. "Our platform enables companies to optimize logistics processes with the help of artificial intelligence without their own infrastructure and without major investments," explains Martin Friedrich. This principle is called "AI-as-a-Service" (AIaaS), based on the well-known Software-as-a-Service (SaaS) model: AI models are provided via the Internet and can be used on a subscription basis.

Fraunhofer IML researchers actively support and advise interested companies with the usage of "Omnistics" – from data preparation to connection to the platform. "We use customized pilot projects and training courses to provide SMEs with the necessary know-how for working with Omnistics," explains Friedrich. Data protection and data storage are also guaranteed: The entire platform is cloud-based, and the data is stored on Fraunhofer IML servers in compliance with data protection regulations and can be accessed securely by companies via an interface.

"We use customized pilot projects and training courses to provide SMEs with the necessary know-how for working with Omnistics"

Martin Friedrich

Practical suitability confirmed

The most important task for the Dortmund researchers is currently the continuous optimization of the AI platform "Omnistics." To this end, the platform was subjected to practical testing. The partner in the beta phase was the logistics service provider Geis, which contributed its logistics expertise to the development of this innovative technology. Geis is a particularly valuable project partner: thanks to the logistics provider's diverse processes, its openness to new technologies, and its commitment to further developing data-based logistics excellence, the platform can be tailored precisely to the requirements of its users. The insights gained from the collaboration are being fed directly into the further development of the platform, which will be available to the industry from fall 2025. In the long term, "Omnistics" and the associated apps will be continuously expanded. Fraunhofer IML is relying on input from freight forwarders, whose experience and suggestions will help to adapt the platform even better to the real requirements of the logistics industry and thus actively shape the future of logistics.

to the video

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The Incredible Journey of a Parcel – How **"Smarcel"** Automates Parcel Delivery

Are you familiar with this situation? There is no parcel shop nearby, your order ends up at a pickup station on the other side of town, or your package has been lost in transit. This marks the beginning of an odyssey that probably everyone has experienced at some point when receiving a package. To eliminate this annoyance, the Bonn-based start-up Innovative Robot Delivery (IRD) has developed the mobile parcel locker Smarcel. Fraunhofer IML and IRD are developing three important product add-ons for Smarcel as part of the "ProtoSAM" project.

The project, which has been running since June 2024, is funded by the European Regional Development Fund (ERDF) and the Just Transition Fund (JTF) 2021-2027. It is coordinated by Project Management Jülich and the Ministry of the Environment, Nature and Transport of the State of North Rhine-Westphalia (MUNV). The aim of the two-and-a-half-year project "ProtoSAM – Prototype Development Location Optimization Tool, Automatic Loading and Unloading, Reusable Packaging" is to develop a technology for the automatic loading and unloading of Smarcels in delivery depots, to optimize the locations of the mobile parcel lockers, and to establish a closed loop for reusable packaging. The journey of a shipment – let's call it Package X – shows how this could look in practice.

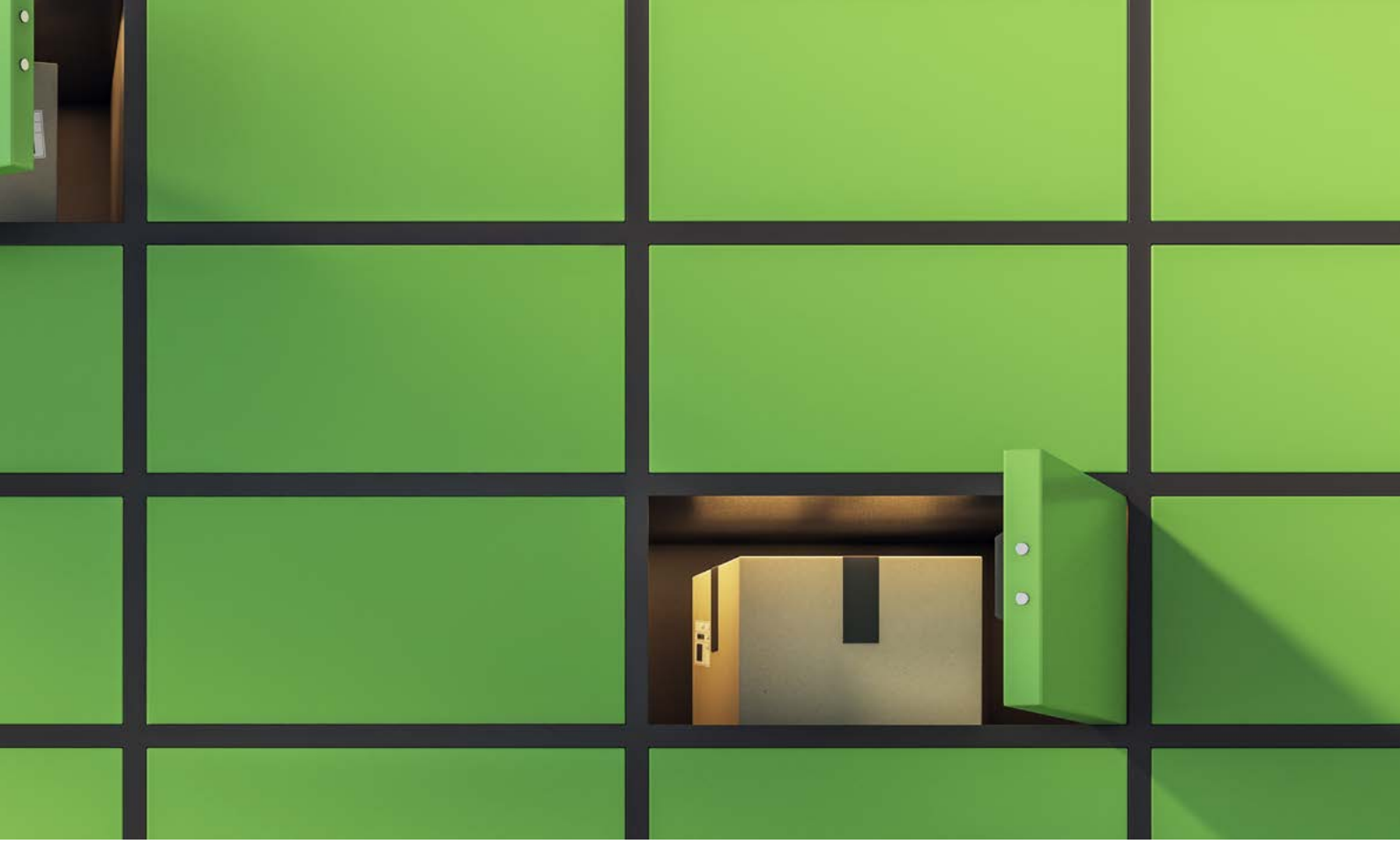
Mobile parcel locker replaces conventional parcel stations

Package X starts its day like any other parcel – in a depot. Along with thousands of other packages, our parcel is waiting to be shipped. Instead of being loaded onto a conventional parcel vehicle, then unloaded manually and handed over to the customer at their front door, Parcel X is loaded onto the "Smarcel" locker – an automated transfer system that is combined with a vehicle or trailer. The mobile parcel locker is the next evolutionary stage of parcel stations and opens up a new dimension in parcel delivery. Thanks to innovative technologies from the "ProtoSAM" project, loading and unloading are fully automated. The "Smarcel" locker is about the size of a small van and fits perfectly on any standard parking space. The data from all loaded parcels is used to determine the optimal location where the vehicle will remain during the day. Customers can pick up their parcels there during this time.

Automated and environmentally friendly delivery

The pickup process is user-friendly and fully automated at Smarcel, from communication to pickup. Another advantage is that goods do not have to be delivered in oversized boxes with unnecessary packaging material, but can be

Images: Who is Danny – stock.adobe.com, Innovative Robot Delivery GmbH



delivered in sustainable reusable packaging upon request, which remains in the Smarcel – so that, unlike previous reusable systems in parcel logistics, a closed packaging cycle is established between senders and parcel service providers, eliminating the need for deposits for consumers and a costly return network.

With "Smarcel", customers receive their orders quickly and conveniently at a location near them. At the same time, the technology helps parcel service providers solve acute problems such as the shortage of specialists. In addition, the closed cycle for reusable packaging contributes to reducing packaging waste, saves over 70 percent of CO_2 emissions on the last mile, and significantly reduces urban traffic – a real win-win situation for everyone involved.

Following a successful pilot of the Smarcel Locker with DHL in Stockholm, IRD and Fraunhofer IML are working hard on the three additional modules to create a fully comprehensive Smarcel product as quickly as possible.

Ministry of the Environment,
Nature and Transport
of the State of North Rhine-Westphalia

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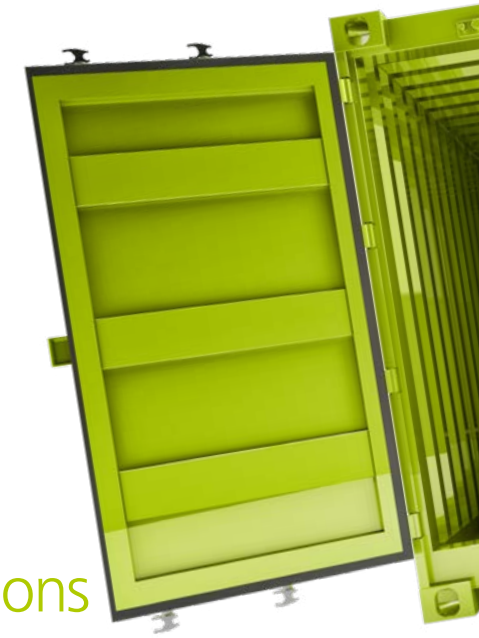


Space for Profit and Planet –

Saving Resources at Warehouse Locations

A container ship leaves the port of Rotterdam early in the morning. It heads for Hamburg. Once there, containers are unloaded. The goods from the containers are distributed to trains or trucks and taken to their intermediate destinations. Here, the goods are sorted, scanned, forwarded, lifted, moved and repacked in large halls. Stowed away, they wait for their onward journey before they reach their destination in a similar way. They are accompanied by their invisible greenhouse gas emissions, which increase from stage to stage.

According to studies by the World Economic Forum (WEF), logistics and the transportation of goods and products account for around 5.5 percent of global CO_2 emissions. As international networking and globalization increase, the trend in emissions is also on the rise. It is not easy to determine the level of greenhouse gas (GHG) emissions in detail, as each industry has different influencing factors that affect emissions. For these emissions to be comparable, it must also be possible to calculate them using the same standards. This is exactly what people have been working on for decades.

As an industry, logistics is very diverse: not only are there different transport routes, but the handling and storage locations are also very different. After all, the goods and products that are stored and transported are extremely diverse: clothing, plasters, bananas, screws, liquid gas, frozen food, chemicals and shelving are just a few examples. Everything that is transported from A to B must be stored and transported according to its respective properties. Establishing comparability for the logistics locations alone is a challenge due to the diversity. "We can't compare apples with oranges, which is why we need an internationally valid standard," says Dr. Kerstin Dobers, deputy head of the Sustainability and Circular Economy department at Fraunhofer IML. She is an expert in calculating emissions at logistics locations and helped develop the globally valid ISO 14083 standard for calculating GHG emissions in the transport sector, which was published in 2023. The standard is the result of decades of work, a few detours and great ambitions: Climate neutrality.

GHG emission targets: From global targets to quantifiable values

GHG emissions have been an issue for politicians, scientists and companies for many years. As early as 1992, it was agreed in the UN Framework Convention on Climate Change that all member states must record and regularly report their GHG emissions. This was followed in 1997 by the Kyoto Protocol, in which it was agreed that the Global Warming Potential (GWP) would be used to convert the climate impact of various greenhouse gases into CO_2 equivalents, making them comparable and illustrating their impact on climate change. The 2015 Paris Climate Agreement, which set the goal of limiting global warming to well below two degrees Celsius, obliged the participating countries to develop national climate protection targets, update them regularly and submit regular reports. The recording of GHG emissions also plays a role here.

The European Union (EU) introduced emissions trading as early as 2005 in response to the Kyoto Protocol. For this purpose, so-called emission rights in the form of certificates were distributed to the industrialized countries that have committed themselves to the Kyoto Protocol. The quantities of emission rights are gradually reduced in order to reduce emissions in the long term. Countries that use fewer emission quotas can sell surplus certificates. This is how the market-based approach of European

emissions trading is created. It is one of the EU's central climate protection instruments. One basis for this is the calculation of GHG emissions.

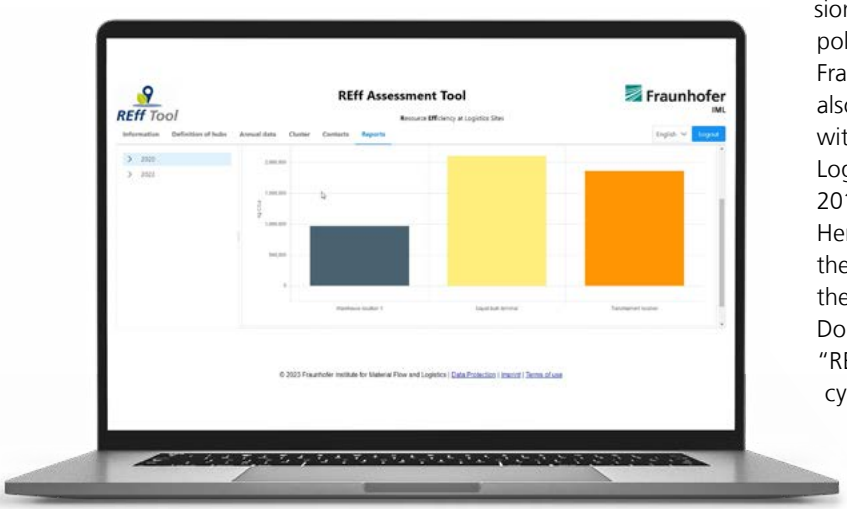
In 2019, the EU Commission adopted the "European Green Deal", or Green Deal for short. This provides for the EU to become climate-neutral by 2050. This was followed in 2021 by the EU Climate Protection Act, which legally binds the Green Deal targets.

Germany also has national laws and regulations aimed at reducing and monitoring GHG emissions. For example, Germany has had the German Federal Climate Protection Act in place since 2019, which sets reduction targets for GHG emissions for various sectors, such as the Energy Sector, industry, buildings, transportation, agriculture and waste management.

However, the conventions or laws did not specify in detail how GHG emissions should be calculated. For this reason, the Greenhouse Gas Protocol (GHG Protocol) was developed at the end of the 1990s by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) as a standard for accounting GHG emissions. The first version of the corporate standard was published in 2001. The GHG Protocol has developed a general approach to accounting for emissions, which is why it is often not sufficient for industry-specific aspects. Over time, others followed, attempting to map the specifics of individual sectors and industries based on the GHG Protocol. Nevertheless, there was still room for interpretation, or they were not used uniformly internationally. In 2012, a European standard for determining GHG emissions in the transportation sector was published, which was only used in Europe.

Data: The foundation of a climate-neutral future

The aim was therefore to develop an international standard for GHG emissions for transport and logistics locations that can be used uniformly and provides meaningful results. It was important that the calculated GHG emissions can also be assigned to the respective polluters and that key figures can be derived. Fraunhofer IML, led by Kerstin Dobers, has also been working on various projects and with various partners – including the Global Logistics Emission Council (GLEC) – since 2019 to promote the international standard. Her main topic: logistics locations. Around the same time as the working groups for the international standard were forming, the Dortmund research scientists published the "REff Tool". REff stands for resource efficiency at logistics locations. And in order to use resources efficiently, transparency is needed, which is provided by the calculation of GHG emissions.



With the help of the REff tool, annual market studies were carried out between 2019 and 2023 as part of the "German, Italian & Latin American consortium for resource efficient logistics hubs & transport" (GILA) research project, which was funded by the German Federal Ministry of Education and Research (BMBF). These are continued with the GILA partners after the end of the project. In the market studies, operators of logistics locations are asked for primary data on annual resource consumption and logistics processes. While only a small number of 196 European logistics sites from 42 companies participated in the first year of the study, more than 150 international companies with almost 1,000 logistics sites are now taking part in the annual market studies, and the trend is rising. Participating site operators receive their individual GHG emission figures, which are calculated in accordance with international standards. The data is used to gain a better understanding of the environmental performance of logistics locations and to close data gaps. "The aim of collecting the data is to create transparency – also for the companies themselves," says Dobers. The findings from the market studies were also incorporated into the development of the international standard, which was published in 2023 as "ISO 14083".

REff tool: Avoid, reduce, decarbonize

The REff Tool supports companies in determining their GHG emissions in accordance with ISO 14083 and has been certified by the Smart Freight Center. The tool enables online data entry, which is required for the ISO-compliant GHG emissions calculation of logistics locations. With the free basic version, the annual GHG emissions and the average emission intensity value per location can be calculated. In addition, Fraunhofer IML offers a licensed version that can, for example, record more than 50 locations, shows the calculated GHG emissions in more detail than in the basic version and enables extended calculations such as taking into account the supplier mix for electricity or emissions from the use of transport packaging.

"Only when I know where the emissions are generated and how high they are can I derive suitable reduction measures. The consumption of resources costs money, such as electricity or fuel. A company can save money and conserve resources by making such adjustments. The key to this is transparency and the REff tool provides this"

Dr. Kerstin Dobers

"Only when I know where the emissions are generated and how high they are can I derive suitable reduction measures. The consumption of resources costs money, such as electricity or fuel. A company can save money and conserve resources by making such adjustments. The key to this is transparency and the REff tool provides this," explains Dobers. The tool also makes it possible to monitor developments and reductions over several years.

"Basically, you can say: reduce, avoid, decarbonize. What that means in detail has to be examined individually," says Dobers. For example, routes and processes that are necessary could be made more efficient, thereby reducing resource consumption and emissions. In addition, the fleet or yard logistics could be electrified and converted to renewable energy sources or "green" electricity.

"Basically, you can say: reduce, avoid, decarbonize. What that means in detail has to be examined individually"

Dr. Kerstin Dobers

Due to the diversity of logistics locations and different legal requirements worldwide, it has not yet been possible to derive detailed and generally applicable recommendations

for reducing GHG emissions. Even though more than 900 logistics locations worldwide have taken part in the market studies to date, the research scientists still face challenges: The locations vary in terms of services, processes, equipment used and resources utilized. In addition, some of the data provided is incomplete, which makes it even more difficult to obtain meaningful, granular results for individual location types. The researchers' aim is to close the data gaps, increase data quality and be able to reliably map all types of logistics locations. This will require significantly more companies to make their data available and more research in location types. However, the market studies are already making it possible to derive initial key figures on the emissions intensity of logistics locations, which are published in the GLEC framework, among others. In addition, companies use their individual key figures for their own calculations, such as in the EcoTransIT World tool, compare their results with those of the market study benchmarks and examine individual savings options.

Sustainability in logistics

The logistics industry in particular is under pressure: globalization is increasing emissions in transport chains, while at the same time emissions must be greatly reduced due to legal requirements such as the Green Deal. In addition, resources are becoming increasingly scarce – and therefore more expensive.

The development of the international standard ISO 14083 to calculate GHG emissions in the transport sector is a step towards creating international transparency about GHG emissions in the transport chain, including logistics locations.

For companies, the REff tool can be a tool for calculating GHG emissions in accordance with ISO standards. At the same time, companies can use it to find ways to reduce GHG emissions, conserve resources and save costs. In this way, logistics locations can position themselves to be future proof in the long term.

to the video

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New Sustainable Hydrogen Ecosystem Drives Energy Transition Forward

Deep in eastern Slovakia, a small bus travels through the hilly landscape. It is the first hydrogen bus "made in Slovakia." The destination of its journey is written on a sign at the side of the road: Košice. With this hydrogen bus, the region around the city of Košice, near the Hungarian border, is one of the pioneers on the road to a future in which alternative drive systems are becoming increasingly important. And the bus is just the beginning.

There are plans to operate more hydrogen vehicles, including waste collection vehicles, tourist boats, and aircraft, but also to use hydrogen for decarbonization in the local steelworks. With the support of Fraunhofer IML in the EASTGATEH2V project, the region is set to become a hydrogen valley by 2031. The aim is to establish an entire ecosystem for production, storage, handling and use. The boundaries of the hydrogen network, which is funded by the European Union with almost 9 million euros, are permeable: a hydrogen network for the whole of Slovakia could be created from Košice, which would also connect neighboring Ukraine.

A holistic approach to the energy transition

The use of hydrogen as a building block of the energy transition requires the development of complete ecosystems that cover all aspects of the value chain and require sound logistical planning – from site planning, transport infrastructure and route planning to continuing education for staff and fleet management. But how do you build such an ecosystem from scratch?

"Numerous hydrogen valleys are currently emerging in Europe," explains Philipp Müller from Fraunhofer IML, who conducts research in the fields of transport logistics and hydrogen. The Westphalian city of Unna is located just under 1,000 kilometers from Košice. There, too, the goal is to use hydrogen for heavy-duty vehicles. Unna wants to drive forward decarbonization in the areas of transport, public transport, and waste disposal. The potential that hydrogen can offer in this context is currently being investigated in a preliminary study by the "H2 Logistics Hub" project, in which TU Dortmund University and Fraunhofer IML are working together. The study aims to show what steps and players are needed to build a hydrogen ecosystem with local partners.

Images: peterschreiber.media – stock.adobe.com, Košice Self-governing region.

Transport infrastructure is crucial

The hydrogen economy encompasses more than just the use of the end product: numerous other aspects must be considered between production and consumption. In addition to the construction of production facilities and use by consumers, transport infrastructure and means of transport are also central to the success of the new ecosystems. Special transport containers, for example, are necessary to meet the specific requirements of hydrogen transport. In the "H2LogisticsOnRail" project, researchers at Fraunhofer IML have teamed up with industry partners to develop a multimodal transport container that can be used on roads, rails, and waterways – a significant step toward the sustainable transport of green hydrogen.

"Fortunately, even in the hydrogen sector, we don't always have to reinvent the wheel," emphasizes Müller. Parts of existing infrastructure can be used or repurposed for hydrogen transport, such as the (transport) infrastructure for ammonia. Ammonia is particularly suitable for storing hydrogen because it is easier to liquefy and has a higher energy density. The potential of decentralized infrastructures for ammonia as a hydrogen derivative for Germany as an industrial location is currently being investigated in the AmmonVektor project, in which numerous Fraunhofer institutes are involved. Researchers at Fraunhofer IML are using large hydrogen and ammonia sources and sinks to model which supply options make the most sense for various application scenarios from a logistical and economic perspective.

"The development of a hydrogen ecosystem requires a strong commitment from all relevant stakeholders, including energy-intensive industries," explains transport logistics researcher Philipp Müller. The steel industry in particular could benefit greatly from decarbonization through hydrogen. Even if a hydrogen bus in a small Slovakian town makes an important contribution to the energy transition, it is only the cornerstone for the emergence of entire decarbonized industries in the future.

With the expansion of infrastructure, the development of new technologies and collaboration of companies, research institutions and policymakers, a sustainable ecosystem could emerge that drives the energy transition forward on a broad basis. The goal is to create an environmentally friendly, efficient, and future-proof economy that paves the way for a climate-friendly society.

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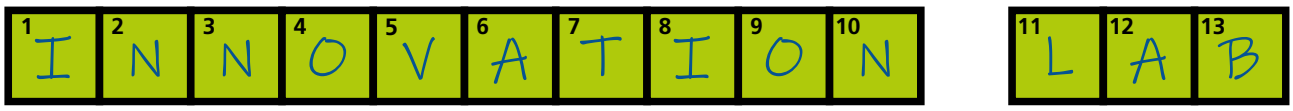
A Load of Questions, **one Answer:**



With the increasing spread of electric cars, various aspects relating to batteries continue to be discussed. Here is a selection: How long do lithium- batteries last? How are they disposed of? How safe is the technology? A web of questions surrounds the topic of electric mobility. The "Innovation Laboratory for Battery Logistics in E-Mobility" (InnoLogBat) at Fraunhofer IML has taken on the task of solving this puzzle.

Among all the questions surrounding electric mobility and the associated lithium-ion batteries, InnoLogBat has identified a total of six questions (and also provided the answers) that address the biggest obstacles, from production and shipping to future drivers:

1. What is essential for making processes, data formats, and interfaces efficient and smooth?

Before a new electric car can finally hit the roads, countless processes relating to the storage, transport, and packaging of the batteries have to be completed. These processes are currently not clearly regulated at either national or international level. The solution seems clear: the implementation of a uniform standard for generating, storing, and forwarding data. This is the only way to enable cooperation between industry, authorities, and scientific institutions.

2. Clear traceability of goods flows and data

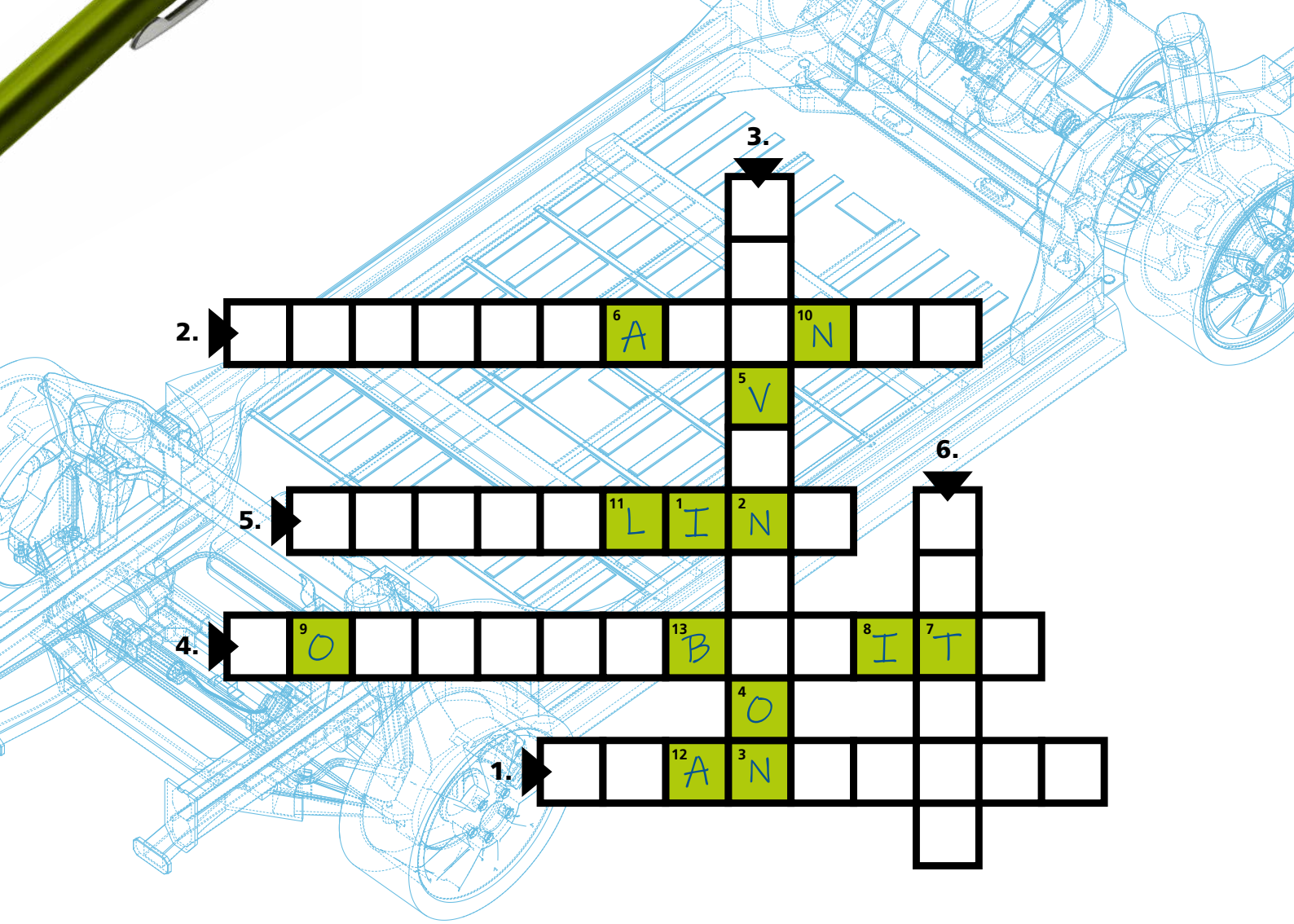
Once communication relating to transport processes has been ensured through the implementation of standards, the transparency of the data generated must still be taken into account. Not only does its availability play a role, but its timeliness and validity must also be clearly regulated in order to make all processes secure and efficient. To enable this throughout the entire transport process and for all stakeholders, the digital battery passport was developed by InnoLogBat. It provides information on the condition, origin, and safety of batteries in a standardized and technically simple and accessible manner. This ensures that small and medium-sized enterprises (SMEs), which otherwise lack resources and access to this data, are also involved.

3. Measures taken in logistics to prevent disruptions, damage, or risks in advance

One of the biggest concerns surrounding e-mobility is the safety of the technologies used. Lithium-ion batteries can be potentially dangerous, for example due to an increased risk of fire or the release of toxic gases if standardization processes and early warning systems are not used correctly. A prevention system has been developed for this purpose, based on realistic scenarios and backed up by theoretical lessons. The aim is to train employees in such a way that they not only learn the technical and theoretical background, but are also able to react appropriately and quickly in emergency situations.

4. What is the term for the ability of different systems or components to work together seamlessly?

From a small bubble car to a fast sports car or a compact car to an SUV – choosing a new car is so much fun, especially because of the huge selection available. However, the types of batteries are just as diverse as the car models. These vary in size, weight, and performance to suit the car. However, this diversity makes it difficult to



achieve a circular economy due to the limited compatibility of batteries. The solution developed by InnoLogBat is based on a track-and-trace system: by tracking batteries throughout their entire life cycle and offering incentives for returns, the recycling process could be promoted until a closed loop is finally achieved.

5. Another word for reusing

"Design for recycling" describes a concept in which the recycling process is considered right from the development stage. In order to develop a self-sustaining cycle, new battery types must be designed in such a way that they are as easy as possible to dismantle and recycle. This is where artificial intelligence (AI) can help to generate data and optimize future designs. The rapid developments surrounding the various battery types require continuous market analysis in order to keep pace with the rapid developments, especially with regard to new technologies such as hydrogen fuel cells or diversified cell chemistry.

6. What do we call the time that has not happened yet?

In the phase of the research project "Innovation Laboratory for Battery Logistics in E-Mobility" completed in early 2025, Fraunhofer IML, together with Leipzig University, the Fraunhofer Heinrich Hertz Institute (HHI) and Remondis Industrie Service, Rhenus Automotive, and Mercedes-Benz Energy, developed these innovative logistics concepts for a sustainable recycling management system for lithium-ion batteries. Due to the rapid development of this industry, the concepts will have to be continuously adapted in the future. But one thing is already certain: the solution to the puzzle of the future remains the innovation laboratory.

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Two International Awards for the "Digital Testbed Air Cargo" project consortium

There is still room for improvement in the movement of goods by air, as the Digital Testbed Air Cargo (DTAC) research project shows. In this project, research scientists are developing digital applications for air freight logistics that make transport chains more efficient. The researchers are working closely with airports and air freight companies to implement the solutions. This allows solutions relating to AI, automation, and e-commerce integration, as well as the ONE Record data standard developed, to be implemented directly on site. The project is funded by the German Federal Ministry for Digital and State Modernization (BMDS) and has a total budget of over 18 million euros.

In February 2025, the research project consortium was presented with the International Award for Excellence in Air Cargo in the category Innovative Logistics Solutions in Air Cargo of the Year at air cargo Africa 2025 in Nairobi. And the next award was not long in coming: In June 2025, the International Air Cargo Association awarded DTAC first place in the "Start-up and Small Business" category of the Air Cargo Sustainability Award. Among other things, the impact on society and industry, ease of implementation, degree of innovation, and the "wow factor" were evaluated.

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Institute Director Prof. Alice Kirchheim Appointed to the Executive Board of the BVL (Bundesvereinigung Logistik) e. V.

Prof. Dr.-Ing. Alice Kirchheim, institute director at Fraunhofer IML and holder of the Chair of Materials Handling and Warehouse Management at the Technical University of Dortmund, was appointed to the executive board of the BVL (Bundesvereinigung Logistik) e. V. in June 2025. With this appointment, the BVL is sending a clear signal about the strategic importance of digitalization, automation, and artificial intelligence in logistics.

As a proven expert in automation and digital transformation in intralogistics, Kirchheim brings extensive experience from science and industry to the table. After working at the "BIBA – Bremer Institut für Produktion und Logistik" and in management positions at STILL and Dematic, she was a professor at Aalen University and Helmut Schmidt University in Hamburg. Since April 2024, she has been institute director at Fraunhofer IML, where her research focuses on autonomous systems and AI-supported logistics, among other things. With her appointment, Kirchheim succeeds Prof. Dr. Dr. h. c. Michael ten Hompel as representative of Fraunhofer IML, who represented the institute on the BVL executive board from 2006 to 2018.

ForestGuard Tool Supports Verification of Deforestation-Free Supply Chains

About one-third of global emissions from deforestation are caused by global trade. After China, EU imports cause the greatest losses from deforestation. Therefore, according to a new EU regulation, it must be proven that no forest area has been destroyed along the supply chain. However, providing this proof can be complicated.

This is where a tool developed by Fraunhofer IML comes into play: At the beginning of 2025, researchers at the institute released the "ForestGuard" tool for deforestation-free supply chains. The open-source software was developed primarily to support smallholder producers who must demonstrate that they are deforestation-free in accordance with EU Regulation No. 1115/2023 on deforestation-free supply chains (EUDR). The project was funded by the German Federal Ministry for the Environment, Climate Protection, Nature Conservation, and Nuclear Safety (BMUKN) and implemented using a coffee supply chain as an example. Since its release, ForestGuard has been available free of charge and is not limited to deforestation-free supply chains. The tool is available for all applications where a reliable information base and verification are essential. It enables the collection of master and process data from relevant stakeholders and offers functions for verification, data visualization, and data export.

to the tool

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FlexRailUnit Research Project on the Way to Flexible Freight Transport Units

Fraunhofer IML and Wecon GmbH from Ascheberg have jointly launched the "FlexRailUnit" research and development project. As part of the project, the partners want to develop modular loading units for container wagons that make maximum use of the railway clearance gauge and enable easy decoupling. This offers various advantages for players along the supply chain: Shippers can use shorter loading tracks and at the same time move higher loads on existing infrastructure. Wagon hire companies can better utilize their carrier wagons and thus increase revenues. Industrial companies with rail connections can respond quickly and easily to changing logistics requirements thanks to the flexible units.

Fraunhofer IML is providing scientific support for the development and construction of the prototypes by Wecon GmbH and is working on a simplified approval concept. The FlexRailUnit project aims to produce two tested prototypes, a test scheme for simplified rail approval, and scientific publications. The modular separation of bogies and load carriers and a faster approval process will not only speed up the transport of goods but also innovation.

Increasing the Competitiveness of Robots Through International Cooperation

Together with the South Korean Daegu Mechatronics & Materials Institute (DMI), Fraunhofer IML will work to improve the global competitiveness of the AI robotics industry in both countries. The collaboration is primarily aimed at further developing AI-based video learning, which should improve the ability of robots to correctly recognize and classify objects. This often poses a major technical challenge, but is essential for autonomous vehicles, among other things. The memorandum of understanding was signed in March.

The declaration is a core component of the Daegu AI Robotics Global Innovation Special Zone, an innovation district where new technologies can be tested. Among other things, test runs of autonomous robots on public roads and the processing of personal image data are permitted here.

The approach taken by the Korean partners enables Fraunhofer IML to implement and test technological developments quickly and with minimal administrative effort. Daegu hopes that the innovation zone will become an important hub for future research and development in AI robotics.

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Pal2Rec Gives Pallets the Recognition They Deserve

Pallets can do more than just carry products: thanks to Pal2Rec (Pallet to Recognition), they could soon ensure greater transparency and efficiency in logistics. Initial results from the Pal2Rec research project show how sensors on pallets provide the data needed to identify weak points and optimize processes. The sensors attached to the pallets record movements, impacts, and tilting along the supply chain. The data obtained in this way is used to train artificial intelligence, which creates an activity profile and automatically assigns logistics processes such as loading or storage.

Based on these analyses, companies can identify specific weak points and optimize processes. Another area of application is predictive maintenance, which allows potential damage to be detected at an early stage. In a feasibility study, the project team tested various sensors and found that even inexpensive models deliver suitable results. This means that implementing Pal2Rec does not have to be expensive. The project, which was completed in February 2025, received around 180,000 euros in funding from the mFUND initiative of the German Federal Ministry for Digital and Transport (BMDV).

“Mobile Robots in Production: Mesh-up“ at automatica

At automatica 2025, the showcase “Mobile Robots in Production: Mesh-up“ demonstrated how mobile robots from different manufacturers can work together in a centrally controlled fleet using the open interface VDA 5050. Ten robots performed transport, transfer, and cleaning tasks in a simulated production area, controlled by a uniform master control system. The realistic environment with storage, machine, and manual work stations provided a practical scenario for automated production logistics.

Fraunhofer IML was also involved, presenting the results of the M2X research project, which is being carried out in collaboration with TU Dortmund University. M2X extends the interoperability of mobile robotics with standardized interfaces for communication with peripheral devices, machines, and systems. The aim is to simplify the integration of heterogeneous robot systems and lower the technical barriers to entry for companies. The live demo showed the direct communication between a Fraunhofer IML robot and an active station. This demonstrated how open standards such as VDA 5050 and M2X enable flexible, future-proof production logistics and create the basis for scalable automation solutions.

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7th Textile Logistics Forum at Fraunhofer IML

In July 2025, the Textile Logistics Forum took place in Dortmund for the seventh time, organized by the Center for Textile Logistics at the Niederrhein University of Applied Sciences in Mönchengladbach (CTL) and Fraunhofer IML. Logistics plays a central role in the textile industry: from raw material procurement to production and distribution to recycling. Against the backdrop of sustainability efforts, new insights and innovations are therefore essential. The Textile Logistics Forum strengthens the regular exchange of expertise between experts from the textile and logistics industries. This year’s program offered practical presentations, guided tours, and opportunities for networking. The focus was on sustainable city logistics, circular economy, innovative sorting technologies and recycling potential for textiles, as well as political and technological developments in textile logistics.

Among others, the projects “Smart to POS” for sustainable city logistics, “ReFi(b)re“ for recycling high-performance fibers in protective clothing, and “CircWool,“ which deals with returning whole wool fibers to the recycling cycle, were presented.

Literature Tip

Successfully Exploiting the Potential of Digital Platforms

Digital platforms can also reduce costs and simplify processes in the B2B sector.

Three publications developed as part of the Silicon Economy research project (see also p. 14) offer practical insights into the integration of open source components. The Silicon Economy Integration Guideline provides an overview of the research project's findings. The "Catalog of Logistic Standard Functions" supports companies in the basics of logistics processes, and the report "B2B Platform Economy Reference Architecture Concept" explains the appropriate architecture for implementing B2B platforms in the Silicon Economy.

to the publications

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