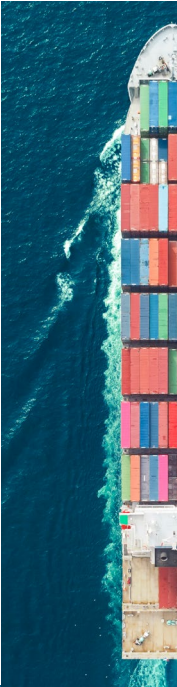# The Importance of Data Standards and Interoperability
in Global Supply Chains

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Rachel Aland

KEY TAKEAWAYS

- **Existing information systems** used in the freight sector are not built on a foundation that supports interoperability, resulting in inefficiencies that prevent widespread digitalization, drive up costs, and aggravate climate change.

- **Open data exchange standards** for multi-modal freight operations are needed to underpin efficient data sharing across the freight sector.

- **Improving data quality, consistency, and access** through a shared vocabulary guarantees interoperability, creating a level playing field for technology solutions that transform data into actionable information.

- **Open data exchange standards unlock next-generation technologies**, such as artificial intelligence applications and predictive analytics, that deliver new insights and identify risks.

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APRIL 2023

Introduction

Global supply chains are in dire need of a technological revolution. As highlighted in the Coalition for Reimagined Mobility's (ReMo) report, *Solving the Global Supply Chain Crisis with Data Sharing*, **every year inefficiencies caused by outdated, nonstandard communication methods lead to billions of dollars in economic losses, 2.5 billion barrels of oil unnecessarily consumed,[1] and excess pollution that harms the planet and our quality of life.**

As goods go from raw materials to products on our store shelves, they pass through dozens of different hands. The information needed to manage these interchanges—particularly around ports—is systematically inaccurate because the freight industry relies on a patchwork of email, phone calls, and other, often antiquated, legacy technologies to obtain usable data on where cargo is at any given time. Still today, fewer than one percent of trade documents are fully digitized.[2]

But the technology exists today to standardize near real-time data exchange in the freight sector, reducing emissions and pollution by 22 percent and costs by 6 percent.[3] In other sectors, from shared mobility to financial services and retail, standardized data exchange allows us to hail a ride within minutes using our smartphones or complete purchases securely online, transforming the customer experience and improving operations and profitability. The freight industry must invest in digital infrastructure and prioritize **open freight data exchange standards**—freely available open

technical specifications on how to share critical information—to phase out the convoluted communications processes that hold the industry back from moving into today's digital world.

This brief builds on the analysis included in ReMo's *Solving the Global Supply Chain Crisis with Data Sharing* by adding technical detail as to how data standards work and how they underpin effective digitalization. The purpose of this brief is to bridge a technical knowledge gap for regulators and other stakeholders on how data standards work and why interoperable, open data standards matter. ReMo's forthcoming publication, *Best Practices for Freight Data Standards Development*, will investigate lessons learned from the development and adoption of existing standards in the transportation sector in order to make actionable recommendations to regulators and freight stakeholders.

How Data Standards Work

The global and highly fragmented nature of freight transportation calls for a common language—a lingua franca—that lays the foundation for communication between supply chain actors. Data standards are simply the modern era's version of such common languages to help efficiently connect participants in a process. This common language is what guarantees **interoperability**, where information can be incorporated into diverse databases and software applications because of a shared understanding of what the data means and represents.
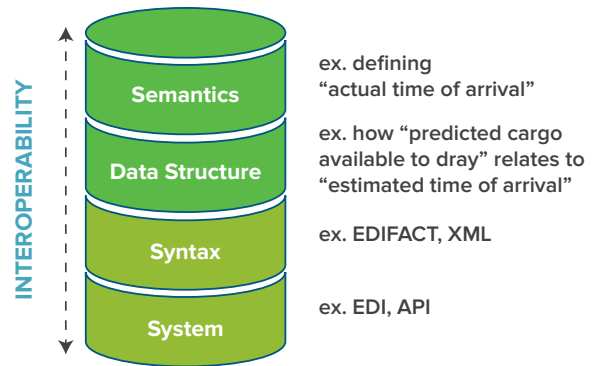
> ● The freight industry must invest in digital infrastructure and prioritize open freight data exchange standards

Components of Data Standards

Fundamentally, data standards make sure everyone in the supply chain is speaking the same language. The language is made up of a shared vocabulary—known as "semantics"—which ensures that before even sharing information, all stakeholders attach the same meaning to data. Shared **semantics**, or semantic interoperability, make certain that stakeholders assign the same meanings to specific terms. For example, freight stakeholders currently define milestones, such as "actual time of arrival" of a vessel, differently. To a ship operator, it could mean "vessel entering the port" while to a terminal operator, "vessel at berth and ready to be unloaded." This misalignment in data definitions could translate to several hours or even days difference, creating significant problems for dispatchers and subsequent stakeholders. These issues are a common feature of the status quo of freight stakeholder communication.

The interactions between these data elements are determined through a data model which maps the **data structure**—the way in which data are organized and interact—to operational processes and data owners. Data models increase data quality and reliability and reduce misinformation. By organizing predetermined vocabularies, processes and structures, data standards work to ensure that data exchanged electronically is well understood. This allows for operational processes to be aligned and properly integrated.[4]

DATA STANDARD LAYERS [5]

INTEROPERABILITY

- Semantics — ex. defining "actual time of arrival"
- Data Structure — ex. how "predicted cargo available to dray" relates to "estimated time of arrival"
- Syntax — ex. EDIFACT, XML
- System — ex. EDI, API

Data standards may also define the **syntax** and the technology, or interface standards, which describes the interaction between systems used in the data exchange. Modern technologies, such as application programming interfaces (APIs), enable real-time data exchange, increasing the reliability and usability of data, and lowering business costs. Standards can support rules of engagement and security specifications while empowering data producers to determine which stakeholders may consume specific data and at which frequency, a critical component of data exchange standards needed in the low trust environment of global logistics for moving freight.

While certain data standards may cover solely the data "vocabulary," or semantics, the other elements of data structure, as well as syntax, are critically important for driving interoperability. This ensures that the data standard is implementable for driving secure data sharing through a marketplace of technologies.

● Today's examples of freight data exchange are far from standardized and current methods are ill-suited to modern day technology applications.

The Purpose Of Data Standards

• **Data standards unlock technological opportunities that improve freight stakeholders' situational awareness and drive collaborative alignment.** By enabling different freight stakeholders to share information efficiently, data standards create opportunities for applications that aggregate information beyond a single actor or individual ecosystem.[6]

• **First, data standards lower the barrier for innovation and drive healthy and competitive marketplaces.** Currently, the lack of reliable and shareable data causes software vendors and users to spend a lot of time and money obtaining and producing usable data. High costs to vendors increase costs to stakeholders such as port authorities when procuring or building tailor-made software solutions that improve operations. By improving the quality of data at the source, data standards avoid the need for costly and time-consuming data sourcing and cleaning, reducing costs to vendors. Freely accessible standards do not favor specific or dominant commercial interests. They create a level playing field for a range of technology and business applications such as marketplaces, digital forwarding platforms, and route optimization tools that optimize operations. Standards ensure that these technology solutions can coexist, as specific stakeholder groups require tailor-made solutions.

• **These technology solutions, supported by data standards, transform data into actionable information** for environmental and cost optimizing decision making. For example, a software provider which consumes near real-time vessel and vehicle location data, as well as information concerning port congestion and weather, could support the smart steaming of vessels at sea. Smart steaming—the practice of matching a vessel's arrival to the availability of

a berth—significantly reduces both emissions from idling and travelling at high speed, as well as operational costs. Standardized vehicle schedules allow shippers to optimize and aggregate loads when travelling from the same origin to destination. Such tools, whether built by carriers in-house, or by third parties as marketplaces, increase revenue-generating capacity and reduce unnecessary emissions from empty runs.

• **Data standards will allow the industry to implement and reap the benefits of next generation technologies** that will drastically improve the sector's ability to manage cargo efficiently and proactively.[7] While advanced sensor technology (IoT) for containers and port equipment are already being deployed with the promise of improving visibility, advanced data processing remains limited. Namely, the quality of data produced in the freight sector remains too low to use predictive or machine learning technologies to the sector's advantage. Improved data quality and interoperability with data standards are needed to drive advanced technology innovation and the better informed, automated decision making needed to improve global supply chain resiliency.

• **Both private and public sectors stand to gain from deeper insights which help to identify risk.** Currently, cargo information is re-keyed multiple times as it moves from one stakeholder to the next, meaning that there is no single source of truth. In port environments, this makes it easier for traffickers to get by unseen. With only two percent of containers globally being physically checked, customs authorities rely on data to identify irregularities.[8] Higher data quality will unlock next generation technologies and make it easier for customs authorities to proactively identify illegal shipments.

From Walled Gardens to Future-Focused Data Exchange

Today's examples of freight data exchange are far from standardized and current methods are ill-suited to modern day technology applications. Existing information exchange systems, including legacy electronic data interchange (EDI) systems and peer-to-peer proprietary software integrations, increase business costs, aggravate fragmentation, and limit optimization. Fragmentation leads to walled gardens, where automation and operational efficiency gains occur in closed ecosystems, without the benefit of widespread interoperability.

Legacy Freight Electronic Data Interchange Standards and Specifications Aggravate Fragmentation

Electronic Data Interchange (EDI) is the most common form of data exchange technology in the freight sector, and while efforts were made to standardize EDI, thousands of standards and specifications are in use today.[9] Additionally, by nature of being unique, machine-to-machine (one-to-one) connections, EDI is exceedingly complex and expensive to maintain, requiring reconfiguration when new data fields are needed. Additionally, EDI does not support either bi-directional, piece-level, or near real-time data exchange: EDI only allows for single-direction of data flow, is exchanged in batch format, and transmissions can take anywhere between 15 and 240 mins.[10] The EDI landscape is fundamentally fragmented and falls short of supporting the more agile and dynamic data exchange that is needed today.

Proprietary, Non-Standardized Solutions Increase Business Costs and Limit Optimization

While streamlined data flows do exist in other industries, the lack of data standards requires costly workarounds when sharing information across the freight sector. These workarounds serve as "translation" systems between different databases, data definitions, and technologies.

THE STATUS QUO IN FREIGHT DATA EXCHANGE REQUIRES BESPOKE, ONE-TO-ONE INTEGRATIONS
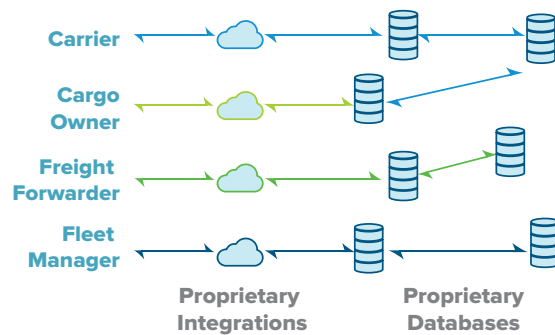
Firstly, data are often maintained in separate databases, containing much of the same information, structured in different ways, which is error-prone and inefficient.[11]

Secondly, the custom, proprietary software integrations required are built on a one-to-one basis, rather than one-to-many, making them costly and not scalable.

Finally, high costs are prohibitive to smaller and medium sized businesses. As a result, digitalization is unevenly distributed across supply chains, and optimization is limited to specific segments and stakeholder groups of supply chains.

Proprietary software standards are aggravating "island automation," customer lock-in, and creating an uncompetitive marketplace for new entrants. This is the case for software vendors that support maritime electronic trade documentation such as electronic Bill of Lading platforms. Currently, customers are only able to exchange electronic documents with stakeholders that are onboarded onto the same platform, and not from one platform to the next. This approach confines platform benefits to individual, walled garden ecosystems, without producing network effects of data sharing. This model tends to rely on lock-in of data (and hence customers), resulting in dominance of incumbents and lock-out of new market entrants.

The status quo of freight digitalization is aggravating information silos and not delivering benefits at scale.

An Opportunity For Improvement: A Future-Focused, Open Freight Data Exchange Standard

An open, vendor-neutral data exchange standard, that is free to access and use, is still needed to drive interoperability and a multilateral approach that meets all freight stakeholder needs. Open freight data exchange standards would reduce costs across the sector and enable software solution providers to successfully coexist, with products built on interoperable data. To enable dynamic data exchange and meet today's operational requirements, data exchange standards should be enabled by API technology, which drives down costs and increases scalability, security, accuracy, and reliability of data.

OPEN STANDARDS ALLOW SYSTEMS TO EXCHANGE DATA MULTILATERALLY

Carriers
Cargo Owners
Freight Forwarders
Fleet Managers
Open Standard API
Open Standard Database
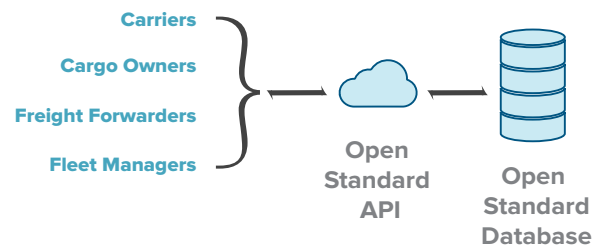
Conclusion

Timely and accurate dissemination of information between stakeholders underlies supply chain resilience and bolsters a healthy and competitive marketplace. Open, vendor-neutral data standards are foundational to successful communication, driving interoperability across numerous technology applications and platforms, and improving the system's ability to be responsive and adaptable.

Other transportation sectors—including micromobility, public transportation, and air transportation—are beginning to develop and adopt data standards. The freight industry is well overdue for a similar upgrade to how its stakeholders securely share information.

How these other industries have integrated data standards—and what lessons this holds for the freight sector—will be explored in ReMo's upcoming publication, *Best Practices for Freight Data Standards Development*. This publication will dive into how inclusive, collaborative, and transparent management and governance can drive the development of open freight data standards that meet industry needs and serve the public interest.

Endnotes

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Acknowledgments

About the Coalition for Reimagined Mobility

The Coalition for Reimagined Mobility (ReMo) is a global initiative of SAFE, advancing new mobility technologies and services to shape transportation systems that are better for people and planet. Bringing together stakeholders across transportation, technology, and sustainability, ReMo conducts research and policy advocacy in the U.S. and Europe to create more efficient, sustainable, equitable, and secure ways to move people and goods. **For more information, visit** reimaginedmobility.org.

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