REPORT

# Are smart containers the way forward?

## A new era for the shipping industry

Roland Berger

# Management summary

Within the shipping industry, despite the value brought by increased transparency, the development of smart containers has been relatively limited in the past, largely following an equipment-on-demand model. Smart containers represent a significant investment for carriers when deployed at scale, and only a limited number of customers have been willing to pay for the service. However, this situation is poised to change, with three major carriers announcing full coverage of their dry container fleets with smart technology.

Comprehensive fleet equipment unlocks new returns on investments for shipping lines, their customers and other stakeholders such as banks, insurers, ports and customs authorities, making smart containers as a key differentiator among carriers.

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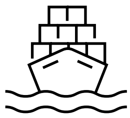
## Fast facts

**3**

**major carriers have announced full coverage of their dry container fleets with smart technology**



Full fleet equipement unlocks new ROI for carriers

**85 %**

Hapag-Llyod has equiped 85% of its dry container fleet

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# Shift of business model: from a dry equipment on demand to full fleet coverage

A smart container is a shipping container equipped with an IoT device affixed to its door, offering GPS positioning, door status, and opening alerts. The inception of smart containers in the shipping market occurred in September 2017 with Maersk's reefer smart container solution, Captain Peter, followed by the 2018 launch of Traxens' solution for dry containers, supported by MSC and CMA CGM at that time. ▶ A

Smart containers often significant advantages to the shipping industry by providing full container visibility, traceability, protection, and cargo quality maintenance–addressing key milestones in maritime container activities.

Despite these benefits, the smart container industry has faced challenges in scaling due to lack of customer's willingness to pay for the additional service, and carriers' difficulties in justifying the internal ROI. Deploying smart containers across an entire fleet of over one

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**A For dry equipment, Smart Container business model is progressively switching, from an *equipment on demand* model to a full fleet coverage**

Smart Container Fleet key development steps

| 2019 | 2022 | 2023 | 2024 |
|---|---|---|---|
| Partial equipment | Full equipment | Full equipment | Full equipment |
| **MSC** Mediterranean Shipping Company<br>**CMA CGM** | **Hapag-Lloyd** | **ONE** Ocean Network Express | **ZIM** |
| **May 2019** | **April 2022** | **February 2023** | **January 2024** |
| After launching the product in 2018, MSC and CMA CGM announced 50k Ctr of CMA CGM and MSC dry fleet will be equipped with TRAXENS devices | Announcement : 100% fleet will be equipped with Orbcomm and Nexxiot devices. Platform developments will be managed internally | Japan's Ocean Network Express (ONE) has announced plans to develop and integrate a smart container solution across its global fleet in partnership with Sony | ZIM has announced an agreement with Hoopo Systems for the wide-scale deployment of tracking devices across its dry container fleet (all fleet) |

Source: Press, carrier's websites, Roland Berger million containers can cost from USD 80 to USD 130 per container, plus a data service fee of approximately USD 2 to USD 5 per container per month. Additionally, device batteries even when equipped with solar panels, typically require replacement every 7 to 12 years, necessitating ongoing fleet maintenance and renewal. For the largest carriers, with fleets around 5 million containers, this translates to a minimum CAPEX USD 400 million, which is roughly 10 % of Maersk's 2023 net profit.

This context explains the initial development of the smart container market, where carriers offered "on-demand" smart container services. Containers were equipped with IoT devices at empty container depot facilities upon request from a paying customer before being released for loading. The industry has relied on specific customer use cases, mainly focused on cargo integrity (theft prevention) and cargo quality (Shock identification). Beneficial Cargo Owners have primarily been willing to pay the additional cost for high-value or sensitive cargo. ▶ B

## B *Equipment on demand* answers specific customer use cases – which can differ per vertical, but mostly addresses high value cargo or cargo integrity

Smart Container benefit per customer vertical

| | Retail & fashion | FMCG | High value | Automotive |
|---|---|---|---|---|
| **Pain points** | Lead time sensitivity | Product quality<br><br>Product contamination | Cargo integrity | Cargo damages during transport |
| **Smart container benefit** | Advanced visibility<br><br>GPS positioning enabling reactivity and emergency sourcing plans. Providing insights into inventory levels & stock moves | Door opening allowing contamination & prevention plans<br><br>Temperature monitoring enabling isotherms cargo packaging costs saving | Door opening and geofencing functionalities allowing thefts occurrences reduction and reinforcement of security measures | Shock detection allowing to better manage product quality |
| **Potential customers** | **Carrefour**<br>**Ikea**<br>**Inditex**<br>**Nike**<br>**Walmart** | **ABInBev**<br>**Diageo**<br>**Nestlé Waters**<br>**P&G** | **Canon**<br>**LG**<br>**Moët Henessy**<br>**Samsung** | **Caterpillar**<br>**Mercedes-Benz**<br>**Stellantis**<br>**Volvo** |

Source: Roland Berger

The shipping industry, characterized by highly volatile freight rates, has struggled to monetize value-added services, often absorbing their costs into global ocean freight.

However, the increasing number and variety of additional services offered by Maersk, CMA CGM, Hapag-Lloyd, and MSC indicate growing customer interest in their value-added services. These offerings enable carriers to adopt a customer-centric approach, differentiate themselves, and create upsell potential beyond standard freight charges.

Since 2017, the smart container market has largely operated on an equipment-on-demand model due to the reasons previously mentioned . Recently, however, three of the top 10 carriers –Hapag-Lloyd (2022), ONE (2023, though yet to materialize), and ZIM (2024)–have announced plans to equip their entire dry container fleets. This shift predicts a sharp expansion in the smart container market.

**"The last few years have brought significant advancements in the smart container industry. Hapag-Lloyd's pioneering decision to digitize its entire fleet opened up new interpretations and applications of smart container technology. Today, a smart container can either be a fleet-wide solution or part of specialized equipment tailored for specific customers, and it may also refer to containers that are 'smart by design'."**

Marianna Levtov
Head of Network & Advocacy Aeler

## 2 Transition to 100 % container fleet coverage

Following Hapag-Lloyd's announcement in 2022, and evidence of progressive fleet equipment, Drewry has published forecasts predicting that approximately 5 million dry containers will be equipped with telematics hardware by 2028. ▶ C

Following Hapag-Lloyd's announcement that it will equip all its dry container fleets with Nexxiot devices, ONE (using Sony) and ZIM (using Hoopo for dry containers) have also announced plans for full fleet coverage. To date, only Hapag-Lloyd has confirmed effective coverage of over 80 % of its fleet.

Besides Hapag-Lloyd, only MSC (with Traxens) currently offers dry smart containers on an on-demand basis. ▶ D

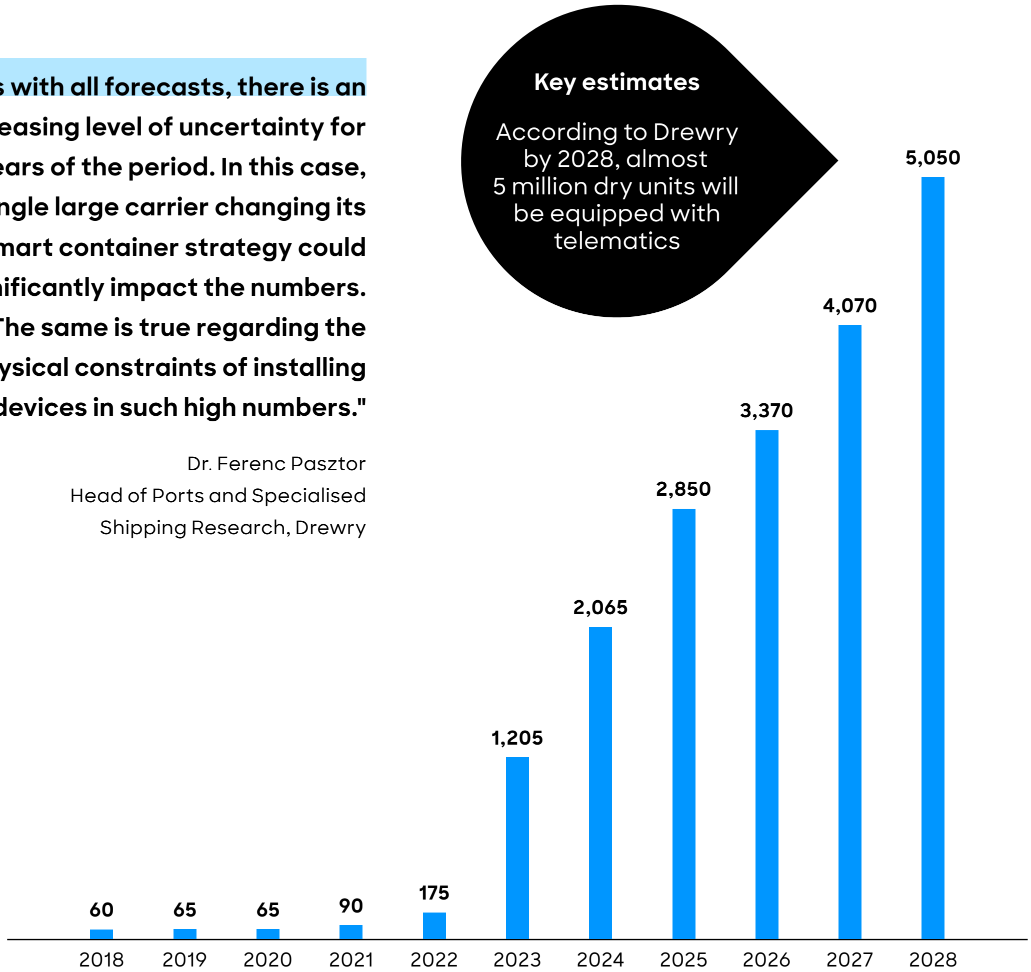
**"The combination of maturing technologies and enhanced solutions that enable large-scale deployment is driving the shift from an equipment-on-demand model to full fleet coverage. Rising customer and industry expectations are positioning smart containers as the new standard, while the benefits of full fleet deployment are accelerating the transformation to smart containers."**

Jeanne Flavian
Chief Business Officer Hoopo

C **Global dry smart container fleet to reach c. 5 million units by 2028**
Global dry smart container fleet forecasts estimates [k TEUS]

**"As with all forecasts, there is an increasing level of uncertainty for later years of the period. In this case, a single large carrier changing its smart container strategy could significantly impact the numbers. The same is true regarding the physical constraints of installing devices in such high numbers."**

Dr. Ferenc Pasztor
Head of Ports and Specialised Shipping Research, Drewry




Source: Drewry

**"Maritime freight digitalization will inevitably result into equipping with smart containers main maritime companies' container fleet. It's been ten years that shipping lines are waiting for devices price to drop and reach break-even, betting on BCO's willingness to pay for a visibility option on top of freight. For three years, ROI based on fleet management seems to have been taking the spot, but it still needs to be demonstrated over the long term. Last deployment decision have also been based on image and reputation- with Hapag-Lloyd reaffirming its #1 position on service quality and MSC leading on cargo integrity and security."**

Cedric Rosemont
CEO, Traxens

## D Full dry smart container fleet coverage has been already announced for 3 carriers within the top 10 – only one project materialized so far

Smart equipment coverage – top 10 carriers

| | Smart Dry Fleet | | | Smart Reefer Fleet | |
|---|---|---|---|---|---|
| | Fleet coverage | Provider | Door opening | Fleet coverage | Provider |
| MSC | 100 k Ctrs equipped | Traxens | ✓ | ~ 60% Reefer fleet | Orbcomm |
| Maersk | No announce | | | 90% equipped (03/23) 390k Ctrs | Sekstant AT & T |
| CMA CGM | No announce since Traxens | | | ~ 15% Reefer fleer | Mainly Emerson |
| Cosco shipping | No announce | | | Limited Ctrs equipped | BOXPLUS & IQAX |
| Hapag-Lloyd | ~85% Ctrs equipped (09/24) | Orbcomm Nexxiot | | ~90% Ctrs equipped (09/24) | Globe tracker |
| ONE | 100% announced (02/23) | Sony | | 100% announced (10/23) | Orbcomm |
| Evergreen | No announce | | | 1 k Ctrs equipped (06/23) | Sekstant |
| HMM | No announce | | | No announce | |
| ZIM | 100% announced (01/24) | Hoopo | ✓ | ~ 70% (on new line Prime Carrier) | Sekstant |
| Yang Ming | No announce | | | 2 k Ctrs equipped (11/23) | Lynx Fleet |

No fleet coverage | Partial fleet equipment coverage | Full equipment announcement **but not materialized so far** | Full or assimilated fleet equipment coverage

Source: Press, Trailer and Cargo monitor tracking, Roland Berger

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## When full coverage unlocks new ROI for carriers such as Hapag-Lloyd

A closer look at Hapag-Lloyd's offer and commercial positioning helps explain why it has successfully moved to full fleet equipment while other carriers have been more hesitant with smart fleet deployment.

Among ROI announcements, Hapag-Lloyd appears to focus its use cases and ROI primarily on fleet management and increasing revenues.

Hapag-Lloyd claims that its global service quality has been enhanced. The strategy of establishing "first in service quality" as a primary guideline makes it understandable that Hapag-Lloyd would want to offer its customers the visibility and transparency provided by smart containers as a differentiation strategy. ▶ E

> **"There are substantial benefits for a carrier to use smart container on the operational side. Among key operational benefits; empty repositioning management and cost reconciliation from the depot."**
>
> Erik Lund
> Managing Director, Nexxiot

### E Among ROI announcements, Hapag-Lloyd seems to be building most of its uses cases and ROI around increasing revenues and fleet repositioning

Carrier's claimed ROI's and smart containers benefits

| | | | |
|---|---|---|---|
| **Maersk** | ● **Reduce waste, increase cargo quality, issue resolution** | ● **Predictive maintenance** | ● Reduce risks of cargo lost and improve security |
| **CMA CGM** | ● Monitor the status and conditions of container and cargo | ● Implement corrective measures | |
| **Hapag-Lloyd** | ● **Use data to provide cust. better service: ETA, customs** | ● **Incentive for carrier haulage sales development** (Visibility) | ● Optimize **empty containers** repositioning |
| **ONE** | ● **Enhanced visibility** | ● Proactive decision-making | ● Improved customer service |
| **Evergreen** | ● **Carbon footprint documented remotely** | ● **Tracking of whereabout and condition of each reefer** | |
| **ZIM** | ● **Elevate service levels** with higher visibility & cargo integrity | ● Reduce operations **cost of claims** | ● **Maximizing asset utilization** |
| **Yang Ming** | ● Facilitate data-driven decision making | ● Predictive analytics of containers, conditions and machinery | |

● Carrier's cost reduction or improved operations ● Increased services to customer and carrier's revenues

Source: Roland Berger

**"We have already equipped more than 85% of our container fleet. We are pretty excited about the initial benefits we see for our customers and operations and we are sure to develop more use cases over time. On the commercial side we enjoy being the first mover to offer real-time GPS visibility on box level to offer advanced digital services. Our customers will have visibility in areas where they were previously blind. In our operations, we can now optimize equipment flows, better ensure availability for customers and avoid unnecessary repositionings – in particular in the inland. This drives match back identification, cuts inland repositioning costs and costs at depots, as well as reduces $CO_2$ emissions."**

Olaf Habert
Director Strategy Office and Program Manager Smart Container, Hapag-Lloyd AG

Interestingly, Hapag-Lloyd's new Live Position offering, launched in April 2024, also includes ETA (Estimated Time of Arrival) functionality and Fast Customs service—all services developed internally based on smart container data.

Hapag-Lloyd's smart container pricing strategy also reveals the carrier's intention to generate additional revenue through carrier haulage. The smart container service is offered for free if customers purchase carrier haulage services. ▶ F

**"The competitive advantage provided by smart containers will only last for a limited time. It is conceivable that all carriers will eventually be equipped. The true differentiation will lie in how this data is utilized; data that clients often fail to fully leverage internally due to a lack of integration capabilities. The differentiation will be driven by value-added services such as hyper-care (alerts), data analysis, and ETA forecasting, among others."**

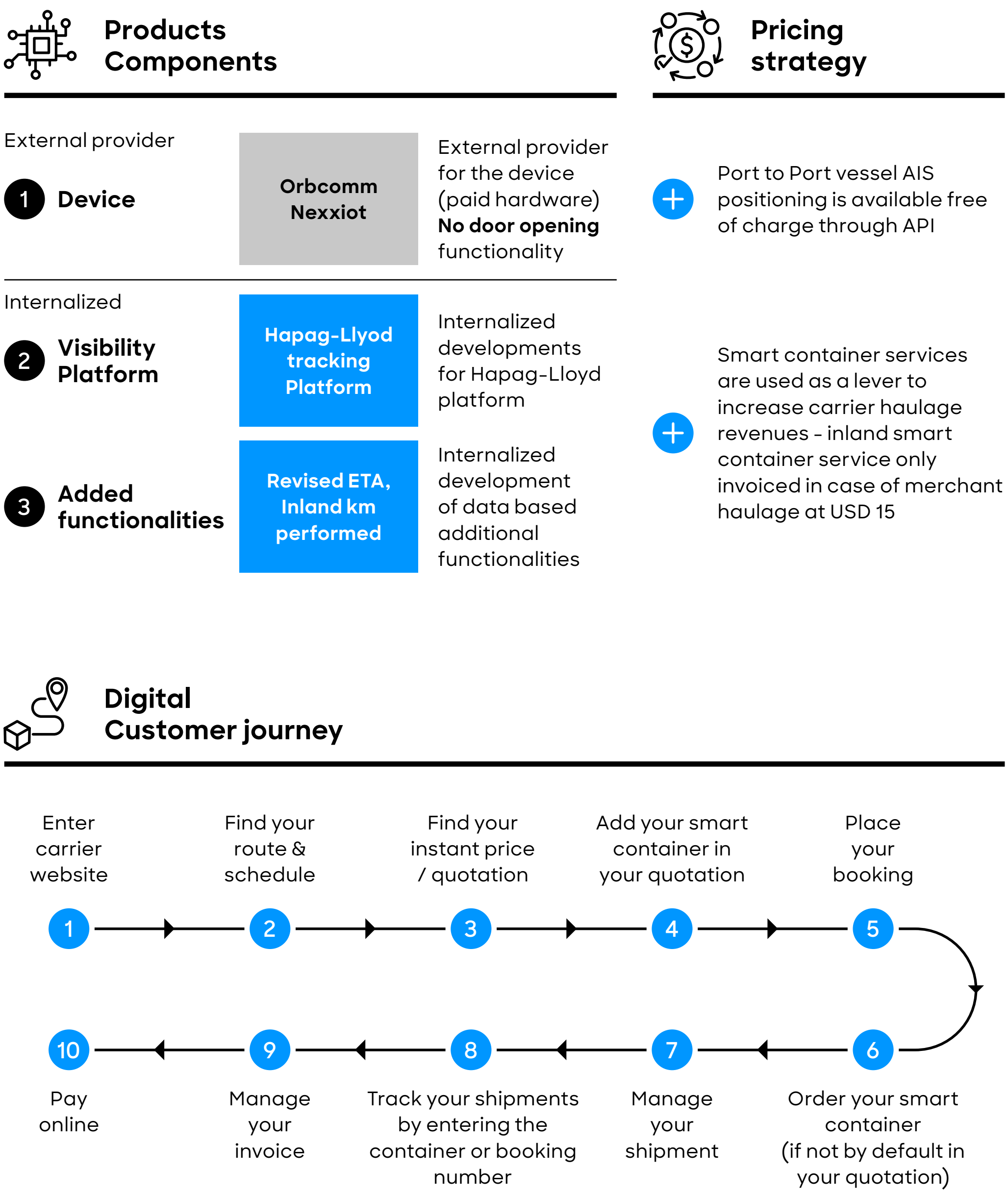
Kathryn Delecluse
Smart Container Manager, MSC

**"When shippers are not satisfied with their carrier's data, they often turn to 3PLs. By providing accurate data on inland services, Hapag-Lloyd's offering could be somewhat compared to that of 3PLs, and the expansion of their intermodal services through smart container offerings could prove particularly relevant."**

Eric Johnson
Director at S&P Global and Senior Technology Editor at JOC.com

## F Live Position, a full-scale smart container offer with an internalized business model

Hapag-Lloyd's Live Position new offer



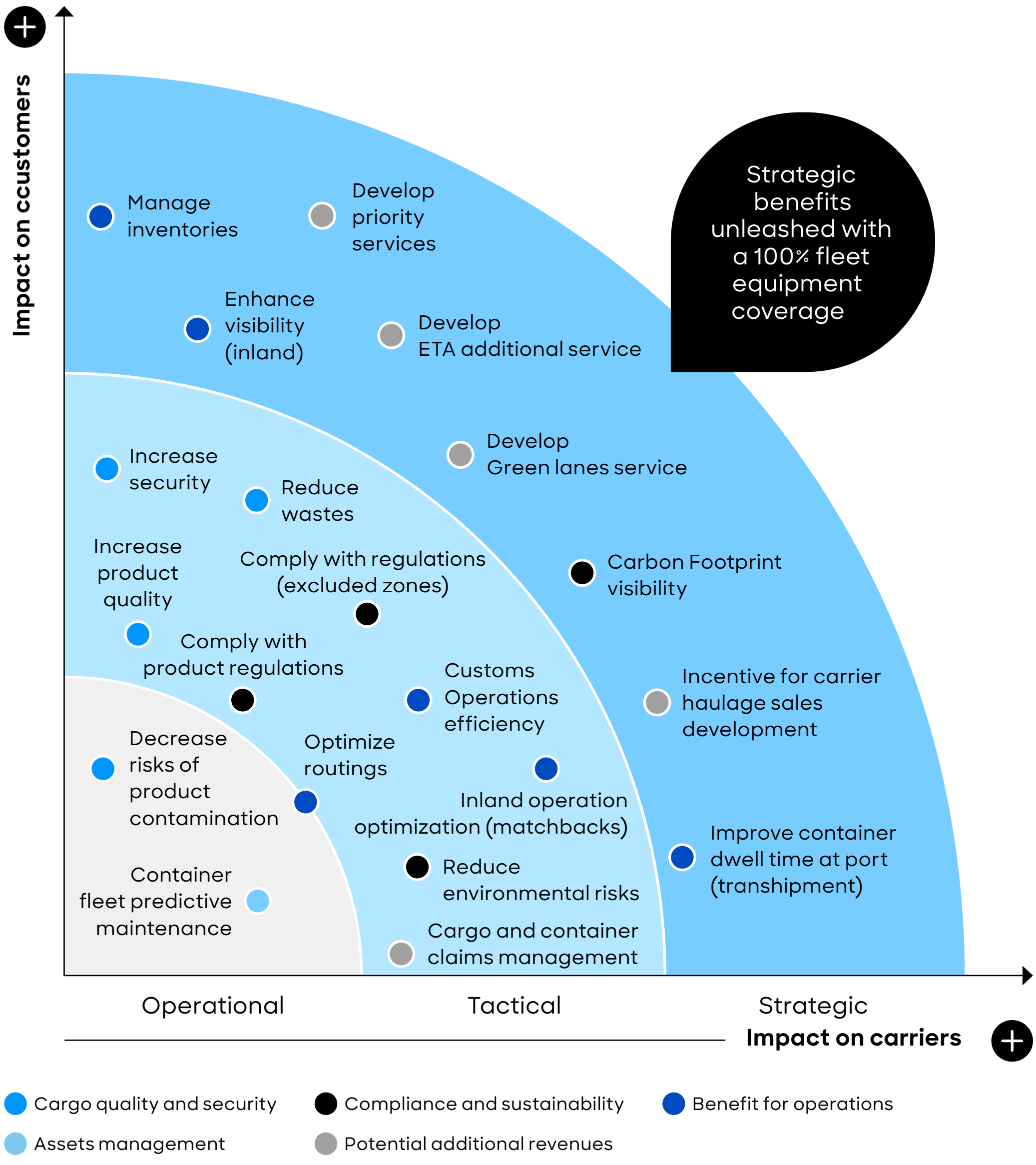

Source: Hapag-Lloyd, Roland Berger analysis

Looking at the benefits of smart containers more broadly, beyond the specific cargo security advantages for high-value goods requiring door opening functionality, it is evident that the strategic benefits of smart containers are fully realized with 100% fleet equipment. ▶ G

**"Hapag-Lloyd decision to go for a full dry smart container fleet has been influenced by several drivers. Based on our positive experience with the reefers for which going full fleet worked better than expected we saw a lot of value potential in creating full transparency across the entire fleet. You start seeing patterns when you follow a relevant part of your fleet over a certain time; and you can connect information in various ways."**

Dr. Sven Gailus
Managing Director Strategy Office, Hapag-Lloyd

## G Full container fleet equipment unleashes strategic benefits for both carriers and Beneficial Cargo Owners




Source: Roland Berger

> **"With the Gemini Alliance, Hapag-Lloyd and Maersk are targeting 90% on-time service. Hapag-Llyod, with its entire fleet equipped with smart containers, will allow its customers to transparently monitor its performance through smart container data. As for Maersk, which has not equipped its fleet with smart containers yet, I wonder how it will manage this discrepancy in between the two partners."**
>
> Eric Johnson
> Director at S&P Global and Senior Technology Editor at JOC.com

It is likely that other carriers will closely monitor Hapag-Lloyd's results with smart containers before scaling their fleets to full equipment coverage. Maersk's next move will also be scrutinized, as it partners with Hapag-Lloyd in the Gemini alliance, with increased operational cooperation and high service quality and reliability. It is plausible that Maersk could be the next to offer a full-scale dry smart container solution.

The success of such deployment will remain in the hands of Beneficial Cargo Owners and their recognition of carrier's efforts to enhance service quality with end-to-end visibility.

> **"Smart Containers are critical to BCOs to enhance operational planning data at logistics hubs and bridge operational visibility gap."**
>
> Pascal Ollivier
> President of Maritime Street and Chairman IAPH Data Collaboration Committee

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## Smart container's benefits to the ecosystem and anticipated regulatory pressure

When considering the benefits of smart containers, it is important to look beyond the ROI for carriers and Beneficial Cargo Owners. Smart containers are set to play a key role in ensuring compliance, fostering customs efficiency, increasing traceability, detecting illegal transportation, reducing theft, and securing the overall supply chain. To fully realize these benefits, the industry must broaden the adoption of smart containers and accelerate standardization and data exchange.

By providing information about a container's journey before it arrives at its destination, smart container devices can accelerate customs processes. If this data is shared with various players in the shipping ecosystem, including customs administrations, smart container data can reduce the number of inspections, streamline clearance procedures, and enhance overall operational efficiency.

Detecting unauthorized door openings or closings can also be used to identify illegal activities, such as drug smuggling. Certain carriers have invested in a fleet of smart containers to combat drug trafficking, achieving notable success. As governments intensify efforts to combat smuggling and terrorism, it is likely that future regulations, especially in regions with heightened security concerns, will mandate the use of smart containers to ensure the safety and security of goods in transit.

> **Sharing the data generated by Smart Containers with Customs administrations can enrich the information they collect and analyze. Two events are of specific interest to them: unauthorized door opening, and route deviation when the container crosses previously defined geofences."**
>
> Gadi Benmoshe
> Aeler, Smart Container reshaping ports and customs operations, June 3, 2024

Industry initiatives such as Operation Tin Can End 2022 - an international multi-regional operation focused on cocaine trafficking led by the World Customs Organization (WCO) – demonstrated that, operational successes were possible through cooperation and use of emerging container security technology such as smart containers. This demonstration could contribute to setting new global industry standards related to the integrity of containerized cargo and strengthening the supply chain against criminal infiltration. ▶ H

## H Other stakeholders' benefits : Foster transparency across the container' value chain

Smart container benefits

| Banks | Insurance companies | Customs & authorities | Ports & terminal operators |
|---|---|---|---|
| Contract compliance of container couting to check the physical transport execution: political risk areas, excepted countries. | Cargo Claim Management (cargo quality and security) | Speed up operational clearance processes | Security Improvement |
| Speed up of trade finance processes | Use of data and statistics to assess compliance and risks | Improve drug detection with door openings occur in non authorized areas | Gain understanding of Ports & Terminal's infrastructure usage and inland connections |
| | Build insurance products depending on trades and/ or type of cargo | Highlight trespassing of a free trade zone | Facilitate segregation of dangerous goods at Terminal |
| | | Improve efficiency of container inspection operation with detection of sanitary parameters (temperature, contamination with door opening, Cold treatment) | Enhance operation efficiency (inland ETA) |
| | | | Ease container number recognition and yard inventory count and registration |

Source: Roland Berger

**"The KYX (know your cargo) initiative focuses on using smart containers to track money ownership, money flow and physical flow, helping to fight against illicit trade and money laundering. This not only improves risks visibility for customs authorities and insurers like TT Club, but it also has great interest for the banking industry."**

Erik Lund
Managing Director, Nexxiot

While no global mandate currently requires the use of smart containers, there is growing momentum towards regulatory frameworks that could make their adoption more widespread, if not mandatory.

For example, smart container data is now being recognized by insurance companies – which should contribute to the adoption of this technology.

**"Detecting unapproved door opening also brings high value when handling insurance claims, since the collected data has legal proof value for the shipping carrier."**

Jeanne Flavian
Chief Business Officer Hoopo

Supply chain security initiatives such as the U.S. Customs-Trade Partnership Against Terrorism (C-TPAT) and the European Union's Authorized Economic Operator (AEO) programs are advocating for enhanced security measures across supply chains and encourage the use of advanced technologies like smart containers, to ensure the integrity and security of cargo.

In the future, to secure supply chains, ease customs processes, and combat drug trafficking, government bodies and international organizations such as the International Maritime Organization (IMO) and the World Trade Organization (WTO) may explore guidelines to promote the use of smart containers as a standard practice for enhancing global trade security and efficiency. Incentives for carriers and shippers who share smart container data, such as fast lanes at ports are likely to be considered to increase smart container adoption and data flows among stakeholders.

**"The smart container market is evolving positively; however, interoperability remains a critical issue, especially with the diverse solutions now being adopted by carriers. The ecosystem must undergo modernization. For further advancement, carriers shall continue their collaborative efforts on standardization, initiated by the DCSA. Only through such collaboration will BCOs be able to fully capitalize on the advantages that smart containers offer."**

Andre Simha
Chief Digital Officer MSC,
Chairman of the Supervisory Board DCSA

To ensure effective data communication across the supply chain, interoperability, data standardization, and data-sharing principles should be established by regulators and promoted by international organizations. The International Association of Ports and Harbors (IAPH) argues that innovation is also about process efficiency. This includes how data flows among stakeholders and how it is used. "Innovation in ports – not only about technology".

# Conclusion

The adoption of smart containers will be influenced by the recognition from Beneficial Cargo Owners and regulatory authorities of the value this technology brings in terms of service quality, security, and compliance. The investment decision remains today in the hands of carrier's and shall be triggered by both internal ROI and ability to increase revenues, both driving additional usage of data beyond track and trace.

Operational benefits for carriers appear clear in terms of fleet management capabilities, but to materialize ROI, the entire fleet must be equipped and accompanied by a transformation of existing processes and equipment management systems. The investment decision also requires a clear strategy with defined milestones and the right organizational set up to fully capitalize on the investment.

Hapag-Lloyd's pioneering decision to equip its entire fleet with smart containers could become widespread as other shipping lines will now be able to make investment decisions based on these results rather than ROI assumptions.

Looking ahead, it is likely that the industry will witness an increase in regulatory requirements around the use of smart containers. As these regulations take shape, carriers that have already invested in smart container technology will enjoy competitive advantages and be better prepared to meet compliance demands.

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