BALTIC RIM ECONOMIES
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The Centrum Balticum Foundation publishes the Baltic Rim Economies (BRE) review which deals with the development of the Baltic Sea region.

In the BRE review, public and corporate decision makers, representatives of Academia, as well as several other experts contribute to the discussion.

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JUSSI SORAMÄKI

Does the freedom of the seas allow sabotage?

Expert article • 3739

The freedom of the seas is the cornerstone of international trade and crucial for our well-being. Maritime transport covers over 80 % of world trade. In 2023, the share of maritime transport in Finland's foreign trade accounted for 96% of Finland's exports and imports. The freedom of the seas is challenged by recent actions against submarine infrastructure in the Baltic Sea. These actions also pose a threat for the security of supply and for the environment.

The first incident, by the Hong Kong registered container ship Newnew Polar Bear, took place in October 2023. Dragging its anchor, it allegedly damaged the Balticconnector gas pipeline between Finland and Estonia, and the EE-S1, a submarine communications cable between Sweden and Estonia. The Newnew Polar Bear was able to exit the Baltic Sea without any attempts to stop it.

The second incident by Yi Ping 3, a Chinese bulk carrier, happened in November 2024. Dragging the ships anchor through the seabed over 90 nautical miles it succeeded in damaging of the submarine telecommunications cable C-Lion1 between Finland and Germany and the Arelion cable between Sweden. After damage, the ship was quickly followed by a Danish Navy ship and Yi Ping 3 anchored at the Danish Straits for inspection which was carried out by the Chinese authorities. Later, a group of observers from Germany, Sweden, Denmark, and Finland were able to join the Chinese investigation team briefly. The ship left its anchorage after a month.

The third incident happened in December 2024, when the tanker Eagle S, registered in Cook Islands dragged its anchor, and damaged the Estlink 2 submarine power cable and four communication cables. The ship was stopped by Finnish Coast Guard and escorted to Finnish territorial waters where it was seized. A port state control was conducted. The inspection report shows serious defects in Eagle S. The investigation by the Finnish Police is ongoing.

Russia has used the so-called shadow fleet to avoid sanctions and to continue oil exports. The shadow fleet is according to IMO a fleet of between 300 and 600 tankers primarily comprised of older ships, including some not inspected recently, having substandard maintenance, unclear ownership, and a severe lack of insurance. It has been estimated that potential number of tankers that could be added to the shadow fleet is up to 2000 vessels.

The shadow fleet poses an environmental threat not only for the Gulf of Finland but for the entire Baltic Sea and beyond. A good example of the threat is the non-manoeuvrable tanker Eventin, which carries oil from Ust-Luga, Russia. It has been towed to German territorial waters to avoid a major oil spill.

The three incidents in the Baltic Sea, The Newnew Polar Bear, Yi Ping 3 and the latest, Eagle S have revealed that the Law of the Sea is less functional when dealing with sabotage.

Steps to solve the problems have already been taken. The recent Baltic Sea NATO Allies Summit, in the presence of the EU, agreed with enhanced NATO presence and made a statement for future action. NATO has launched the enhanced Vigilance Activity Baltic Sentry to improve situational awareness and deter hostile activities. It has also activated the Commander Task Force-Baltic in Rostock which coordinates Allied ships in the Baltic Sea. NATO´s Maritime Centre for the Security of Critical Undersea Infrastructure and NATO´s Critical Undersea Infrastructure Network is going to support efforts to protect and secure undersea infrastructure. A Memorandum of Understanding on Critical Infrastructure Protection in the Baltic Sea region will be drafted.

First, a surveillance system which was also proposed by JEF that detects any unusual movements close to submarine infrastructure, will be established. The system would allow for a quick response if something unusual is happening. An enhanced co-operation between NATO, EU and national operators is needed. Co-operation and shared situational awareness at all levels is key.

Re-negotiating conventions such as the UNCLOS normally takes a very long time and the chances for a desirable outcome are not very high. Instead, we should study the existing conventions such as UNCLOS if allows for new interpretations. The NATO Baltic Summit decided to identify further measures in accordance with international law of the sea, including the freedom of navigation, to prevent and effectively respond to wilful damaging of critical undersea infrastructure or irresponsible behaviour. The foreign ministries will jointly work on the matter.

Sanctions can be very effective. A part of the shadow fleet tankers has already been sanctioned and this should be continued, but we should not forget to target the shipowners, too. The sanctioning of the oil receiving ports and refineries, when possible, could prove very effective.

It is important to contact the flag states directly and work with them. The Finnish Government started the talks already in 2023 when visiting Panama and we expressed our serious concerns about the increased risk of an accident and an oil spill in the Gulf of Finland. The discussions with the flag states are being continued at the highest level in Finland.

Several actions to prevent future sabotage on submarine infrastructure have been proposed now as well as how to deal with the dark fleet. Now it is time to act and work together with all stakeholders concerned.

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MAXIMO Q. MEIJA JR.

Challenging the resilience of the global maritime system

Expert article • 3740

The current surge in disruptions to the global supply chain have lengthened vessel trade routes, endangered the safety of navigation, and compromised the security of seafarers. In an interconnected world, this has implications on economics and development in all regions of the world.

Since late 2023 the Houthis have deployed drones and missiles against maritime targets, ostensibly as a campaign to prevent Israel-linked ships from passing through the Indian Ocean. More than a hundred vessels have reported being attacked. A number of ships have been hit. At least one ship has sunk and another has suffered a loss of lives. On yet another ship, 25 seafarers continue to be kept as hostages after more than a year.

In the Black Sea, no less than three vessels were hit by missiles in 24-25 February 2022, the first two days of the Russian invasion of Ukraine. Ships trading in the northern part of the Black Sea continue to be on heightened alert today and recent months have still seen sporadic missile attacks against merchant shipping.

Somali piracy, largely dormant for more than a decade, showed a resurgence last year. In the first quarter of 2024, no less than five incidents related to Somali piracy have been reported, compared to zero in the same period the previous year. Close to two dozen seafarers were held hostage by Somali pirates before finally being released in April 2024.

Aside from the horrific risk of injury, and sometimes death, suffered by seafarers, the disruption to the global supply chain is having a catastrophic cumulative effect. A 42% decrease in trade volumes have been noted in the Red Sea region. Regional ports have seen a 'double-digit' decline. One transhipment hub saw a 90% drop in capacity calling at the port. Ships are diverting around the Cape of Good Hope, trebling bunker consumption, adding 18 days of transit time, and representing a threefold increase in carbon credit costs under the EU emissions trading system this year.

In the Black Sea, even with the opening of the new Black Sea corridor, maritime traffic volumes are still more than 50% down on pre-war levels. Russia continues to disrupt Ukraine's seaborne trade, targeting the infrastructure of both the Black Sea ports and Danube River ports, and has also hit several merchant ships. Some Ukrainian farmers are at the verge of bankruptcy and create further disincentives to plant for the next crop year. As Ukraine typically accounted for about 10% of global wheat exports before the war, the effect on global markets is akin to back-to-back droughts over three years in a major wheat-producing region. Tight stocks mean continued high prices and volatile markets. Both Russia and Ukraine are major producers of staple food items, and they provide 90% of the wheat supply to many low income countries in Eastern Europe, Asia, and Africa. The impact of this war on the global supply chain has been linked to food shortages around the world.

Indeed, the Lloyd's List Outlook 2025 report indicates that geopolitical risk is seen as the number one worry for shipping businesses over the next two years. This is the third consecutive Lloyd's List Outlook report with this finding.

Among others, this begs the questions, "How resilient is the global maritime system?" and "How readily can it recover from setbacks?" While, for lack of material time, this article mentions only the Red Sea, Horn of Africa, and the Black Sea, the above questions are posed in the context of current geopolitical upheavals in other regions – of which there seems to be an abundance in both quantity and level of threat to security. A simplified response would underscore how shipping has always demonstrated resilience in the past and it always will. Shipping has centuries of experience in adapting to change and disruption. Adaptation and resilience are in fact not choices, because trade must go on no matter the challenges. Shipping continues to be the most efficient and environmentally efficient way to move international cargo. One need only recall the COVID-19 pandemic of the distant past; when all the airports were closed and road frontiers between states were locked down, who carried world trade? Ships and seafarers!

Fuel needs to be transported and basic essentials need to be delivered. There is simply no viable alternative to maritime transport in terms of the volumes in world trade. Fortunately, the maritime industry is resilient. Having said that, there is a price to resilience. Rerouting, risk to life and limb, captivity, additional operating expenses, increased uncertainty, etc., are only a few in what would seem to be an endless list.

Our modern-day heroes, the seafarers still save the day for us. Thanks to them, in spite of all the geopolitical, environmental, and other challenges that come our way, the shipping industry delivers. They bring us our food, our clothing, our fuel, even allowing us — often less admirably — to pander to our indulgent consumption habits.

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Enhancing the resilience of the global energy shipping network

Expert article • 3741

Energy is not just a vital strategic resource but a time-sensitive one that drives a nation's social and economic development. The energy supply chain, integral to the rhythm of economic growth, must operate smoothly and efficiently for the seamless functioning of all processes, from energy production to delivery to end consumers. A stable energy supply chain is not just a component of national security but a critical one. However, recent geopolitical shifts have disrupted shipping routes and significantly impacted the global energy market. These changes underscore the urgent need to enhance the resilience and security of the energy supply chain, a primary challenge for the global energy industry that cannot be delayed.

While pipelines can facilitate short-distance energy transfers, globalization has made maritime transport the primary method for moving energy across long distances. In 2023, the global oil supply reached 101.9 million barrels per day, with maritime oil trade accounting for 77.5 million barrels, or 76% of the total. This vast network relies on thousands of shipping routes worldwide. However, narrow straits along these routes can restrict vessel size, and any blockage—whether due to geopolitical tensions, natural disasters, technical failures, or other factors—can disrupt these routes. Such disruptions increase transportation time and costs, potentially breaking down energy supply chains. This is particularly impactful for small island developing states and least developed countries, which often rely heavily on imported energy and have limited resources to address disruptions. While the future is uncertain, it is clear that a resilient energy shipping network is essential to mitigate these risks.

What can be done to address these challenges? Are we limited to merely preparing for sudden interruptions and monitoring vessels as they navigate these routes? The solution is complex.

International collaboration is not just important, it is vital for enhancing the resilience of the energy shipping network. Global shipping cooperation is essential because individual nations cannot tackle major challenges alone. Countries must work together to strengthen the anti-cyclical capacity of shipping enterprises through inter-regional cooperation. Anti-cyclical capacity refers to the ability of shipping enterprises to adapt and respond effectively to changes in the global energy market, ensuring the stability and smooth flow of global industrial and energy supply chains. For instance, COSCO Shipping leverages the port of Piraeus in Greece to integrate air routes, ports, and railway resources, creating a China-Europe land-sea express line. This line serves 71 million people across nine countries in Central and Eastern Europe, becoming a key trade corridor between China and Europe, thereby bolstering the resilience of the energy shipping network.

From a micro-network perspective, ports play a crucial role in enhancing the resilience of the energy shipping network. Port infrastructure capacity ensures the network's safe, efficient, and orderly operations. Ports must proactively build and reserve capacity to manage environmental risks, improve surplus capacity, and increase the direct rate of arriving ships. Additionally, ports should allocate a balanced mix of large, medium, and small berths, emphasizing larger berths to better match arriving ship types. This allocation strategy can help reduce congestion and waiting times, enhancing the network's efficiency. Furthermore, strengthening shipping service capabilities and forming clusters of shipping-related services in finance, law, and technology can further improve a port's ability to handle sudden increases in transport demand, ensuring the stability of both domestic and international supply chains.

An intelligent and efficient energy shipping network is the backbone of smooth energy transport. In today's global shipping industry, hundreds of thousands of ships navigate the oceans, exchanging vast amounts of information among over 5,000 ports, 6,000 shipping companies, hundreds of thousands of freight forwarders, and millions of trading enterprises worldwide. Accelerating the digital and intelligent transformation of the shipping industry is crucial. Digital platforms and information-sharing systems enhance collaboration among industry players. By sharing data and best practices—such as real-time information on weather conditions, port availability, and supply chain connectivity—shipping companies can better plan and coordinate responses to disruptions.

While the challenges are daunting, the potential for a resilient energy shipping network is promising and within our reach. By taking consistent, responsible actions with an open and proactive mindset, we can enhance the resilience of the energy shipping network in a world full of uncertainties. This potential for resilience should inspire hope and determination in our collective efforts as we strive toward a more secure and efficient global energy shipping network.

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Maritime choke points controlling the global logistics chains

Expert article • 3742

The global shipping market, responsible for over 80% of international trade has for centuries been the backbone of the world trade, providing a reliable and cost-effective mode of transport for the goods. Already in the 17th century, Hugo Grotius presented the idea of Mare Liberum or freedom of the seas, acknowledging the importance of free movement of goods for the global trade. To guarantee the undisturbed flow of goods, the international community has for long worked for a global regulatory framework. Preceded by the Convention on the High Seas, the United Nations Convention on Law of the Seas guarantees the world commercial shipping the freedom of the seas in high seas, and rights for innocent and safe passage also on the territorial waters and exclusive economic zones under the jurisdiction of nation-states.

During the recent years, however, the free flow of goods on the seas has become increasingly disturbed, for various reasons. In March 2021, container vessel Ever Given ran aground at the Suez Canal, blocking this important transit route of the Europe-Asia -trade for six days, causing delays in delivery and interrupting supply networks globally. Since October 2023, the traffic through the Red Sea has been disturbed by Houthi rebels from Yemen, who have constantly been attacking transiting commercial vessels, causing as much as 60% of the traffic to reroute around the Cape of Good Hope. For the vessels and the goods they transport, this corresponds to as much as 60% more time consumed on a Europe-Asia journey, with corresponding increases in fuel consumption, costs and loss of earnings potential.

In 2024, the Panama Canal authorities were forced to limit the traffic through the canal due to environmental reasons. The lock system of the Canal is mostly operated by supplying water from Gatún lake, a reservoir that is filled with rainwater. Due to a prolonged drought and low amounts of rain, the supply of water has been insufficient to maintain the desired level of operations, causing delays and rerouting of vessels. In case of the Panama Canal, the alternative is just as challenging as in the case of Suez Canal – the only alternative route from Atlantic to the Pacific Ocean is around South America. The transit volumes of the canal have since recovered, but considering the advancing climate change, further difficulties are likely to emerge during the coming years.

Finally, geopolitics has also entered the discussion. After his election, Donald Trump initiated a discussion, suggesting that the Panama Canal should be in the control of the US, to secure the flow of American goods and equipment. In Europe, an example of smaller scale on the importance of controlling passages has been demonstrated for a while. Since occupying Crimea, Russia disturbed the traffic, especially Ukrainian, to and from the Sea of Azov by limiting the size of the vessels and by organizing vessel checks delaying the transports.

Securing safe, fast and undisturbed movement of goods is crucial for various reasons. For individual companies and supply chains, it is a matter of competitiveness. For a long time, supply chains have been accustomed to a seamless flow of goods, emphasizing "lean" approach, scale economies of centralized production, global sourcing and reduction of inventories. The Covid-19 pandemic was one of the first wakeup calls for the supply chains to consider the vulnerability of their strategies, as lockdowns reduced the throughput of key nodes, causing product and component shortages and ultimately reduction of production in many key industries.

For the land-based modes, the dense network of roads and railways usually provide a viable alternative in case a route is cut out for some reason. For shipping, however, the situation is in practice different. Even if vessels are able to navigate freely on the high seas, a large share of the volumes transit through a small number of narrow straits and canals. For example, 30% of world container volumes transit through strait of Malacca, and the strait of Hormuz is of similar importance to world oil trade. Even a minor disruption in either of them is instantly seen not just in the shipping market, but more widely in the world economy. The recent years have shown that these, along with a handful of other chokepoints of world maritime trade. For example, for a shipment to reach Central Europe from Asia, the normal route passes through East China Sea, South China Sea, Strait of Malacca, Strait of Bab el Mandeb, Suez Canal and Gibraltar. A disturbance in any of these chokepoints will lead at least into delay, in many cases rerouting of transport. In case of a shipment destined to the Baltic Sea, two additional chokepoints, the English Channel and the Danish Straits can be added to the list.

For the supply chains, as well as for the national security of supply, this means that the control is slipping further away from home base. The distant chokepoints are away from national governance, giving limited possibilities to keep them open in case of disruption. In some cases, blocking a chokepoint means in practice that the entire transport lane is closed, and accessibility to entire regions might be in jeopardy. Just as an example, the entire Baltic Sea is dependent on the openness of the Danish Straits – with maritime volumes in such a scale that modal shift would not be a possibility.

As this is the case, the only alternative is to refine supply chain strategies. For a long time, the motivation behind multiple sourcing, a procurement strategy to obtain services from multiple, rather than single supplier, has been mainly motivated by the potential of a supplier being unable to deliver as agreed. In today's world, the "default risk" of the transport route should emphasized increasingly in the sourcing strategies. Considering the complexities of the world trade, this most likely means also increased nearshoring bringing more of the sourcing closer, behind less chokepoints, for transport chains to be more controllable, and with more alternatives to adjust if needed.

During the recent years, the geopolitical situation has to some extent driven the world towards "friendshoring", referring to a phenomenon that countries are increasingly trading with trade partners sharing similar political views, consequently reducing trade between the political blocks. Similar approach could be discussed in transport and shipping context as well, considering whether the chokepoints are under friendly control or not. Some recent political comments signal that this kind of discussion is likely to take off also in the West. However, for example China has taken this kind of approach already for a long time with its Belt and Road initiative, with a stated purpose to build and maintain alternative transport corridors

for its foreign trade. Because of this, for example the Arctic has gotten increase interest, as the Northeast and Northwest Passages, and most likely in the coming decades also the Transpolar Route, are considered increasingly viable alternatives for the traditional main shipping lanes.

All of this requires increased knowledge and understanding of the complex and interconnected situation. For the supply chains of the 21st century to be able to be resilient, a deeper knowledge on factors impacting the chokepoints of the world trade. As these include themes from climate change to geopolitics, it is by no means an easy task. At the same time, the ones responsible for security of supply should have a detailed understanding on the supply chains often opaque for the outsiders. This requires both interdisciplinary collaboration, as well as a new mindset, where new themes such as resilience are emphasized.

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Restructuring of global maritime supply chains

Expert article • 3743

Recent geopolitical events have emphasized the need to de-risk supply chains and diversify suppliers and markets. The COVID-19 pandemic, the war in Ukraine, Red Sea tensions, and Panama Canal disruptions have accelerated this trend, leading to a focus on building resilience and self-sufficiency in supply chains.

a) Maritime supply chain restructuring

Over the past decade, maritime supply chain restructuring trends have become evident, particularly in Asia. Since 2010, the distance traveled per ton in container trade has decreased due to increased intra-Asian maritime trade, supporting manufacturing activities in China and its neighboring countries. This reflects a shift towards China becoming the global manufacturing hub, supported by intermediate goods from East Asia. As China becomes more self-reliant in producing components and intermediate goods, imports from distant locations have declined.

Impact of geopolitical tensions

The ongoing trade wars between the United States and China since 2018 have imposed additional costs on their mutual trade, affecting manufacturing industries in both countries. The US tariffs impacted around 18% of its imports, while China's retaliation affected 11% of its imports. Countries like Canada, Mexico, India, Vietnam, and the European Union have benefited from these shifts.

The COVID-19 pandemic, global logistics bottlenecks in 2021-2022, and the war in Ukraine have accelerated changes in trade patterns. Companies are adopting strategies to improve their resilience, such as supply chain restructuring, shifting production to new locations, re-shoring, near-shoring, and friend-shoring.

"China Plus One" strategy

To reduce overdependence on China, many companies have adopted the "China Plus One" strategy, which involves diversifying operations outside China while maintaining a presence in the country. This strategy has implications for container shipping demand and transportation costs, as companies like Apple, Samsung, Sony, and Adidas shift some production to Southeast Asia. As a result, the share of US imports from countries like Taiwan, Mexico, Vietnam, and the European Union is increasing. Meanwhile, the share of US container imports from China has declined, although China remains a major player in global trade.

b) Maritime trade and challenges

The maritime sector continues to face challenges, including geopolitical tensions and the need for a more sustainable, decarbonized future. International maritime trade volume contracted by 0.3% in 2021, reflecting the normalization following the market volatility of 2021. Despite these challenges, the sector remains resilient, with seaborne trade expected to grow by 3% in 2023.

Container transportation

Container transportation plays a significant role in maritime trade, accounting for over 60% of the total cost of cargo transported by sea. Recent events, such as the Ever Given incident and Red Sea tensions, have highlighted the importance of the container market in shaping global trade.

In 2022 and early 2023, the rebalancing of supply and demand in container transportation and the reduction in port congestion led to a rebalancing of container freight rates. However, excess supply of container ships and the Red Sea tensions have created challenges for the industry.

The total container ship capacity is expected to reach 31.9 million TEU by the end of 2025. The excess supply of ships has been somewhat alleviated by the Red Sea tensions, which have led to increased freight and insurance rates as major shipping companies divert Asia-Europe traffic to alternative routes.

Impact of red sea tensions

The conflict in Israel in October 2023, which later became regional, has significantly impacted maritime trade. Attacks on ships in the Bab el-Mandeb Strait have led to disruptions in Asia-Europe supply chains, increased costs, and delays. This has resulted in a shift of traffic to the Cape of Good Hope route, leading to higher costs and emissions.

The diversion to the Cape of Good Hope has brought significant costs and disruptions, particularly for European supply chains. The longer route increases sailing time and fuel consumption, adding to overall costs.

c) Global trade disruptions

The United Nations Conference on Trade and Development (UNCTAD) has highlighted the impact of disruptions to key global shipping routes like the Suez Canal, Panama Canal, and Black Sea. These disruptions have led to significant changes in trade routes, increased costs, and heightened uncertainty.

Economic and environmental costs

Diverting ships around the Cape of Good Hope instead of the Suez Canal incurs both economic and environmental costs. Longer travel distances increase trade costs, insurance premiums, and greenhouse gas emissions. Developing economies, particularly those in South America and East Africa, are heavily dependent on these routes and are vulnerable to such disruptions.

Rising prices and climate impact

UNCTAD warns of the potential economic impacts of prolonged disruptions in container transportation, which could lead to higher costs, inflation, and delays in deliveries. The higher freight rates will eventually be passed on to consumers, affecting global supply chains.

Moreover, the need to maintain trade schedules has led to increased vessel speeds, resulting in higher fuel consumption and greenhouse gas emissions. The higher emissions from longer distances and faster speeds could significantly impact the environment.

As conclusion, the global maritime sector faces numerous challenges due to geopolitical tensions, changes in globalization patterns, and the need for sustainable practices. As companies adapt to these changes, the maritime industry will continue to play a critical role in global trade, despite the uncertainties and risks ahead.

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The digital key to global supply chains

Expert article • 3744

Sustainability, efficiency, resilience, security – just a few of the "big words" dominating today's international shipping industry and global supply chains with all their complexities. From geopolitical upheavals to trade disruption to economic downturns to the impact and implications of climate change, we are without doubt living in an ever-more challenging world. But global trade and supply chains must continue to deliver, despite it all.

The solutions? We hear a great deal about larger ships, new trade routes, supersized container terminals, higher quays, deeper berths, upgraded road and rail links, new fuels and the drive for decarbonisation. All of these options have one thing in common – to be any use at all, they must be underpinned, facilitated and optimised by digital solutions.

Sustainability isn't just about 'being green' – it is about efficiency, reliability and reduction of waste, all of which absolutely depend on digital platforms and services. Yes, massive new ports can be built, developed and expanded – but the ships, trucks and cargo will soon be grinding to a halt in pandemonium if you don't have advanced digital information systems in place to keep everything running smoothly.

This is not about the future. Port Community Systems (PCSs) and Single Window operations have been established for decades and are key to efficient port operations around the world. They enable the electronic exchange of information that keeps cargo flowing 24/7 – they deliver predictability, transparency and reliability. In short, PCSs and Single Windows bring everything together, through a unique collaboration of humans and data.

Since its inception in 2011, the International Port Community Systems Association (IPCSA) has highlighted and defended the vital role of PCSs in efficient, effective supply chains.

Now IPCSA's management team and members are looking towards, and beyond, the horizon, in a unique Foresight exercise which is identifying the trends that could impact PCSs and considering how the PCS industry should respond.

At our first Foresight workshop, held in Dubai, Mona Swoboda, Program Manager of the Inter-American Committee on Ports (CIP) at the Organization of American States (OAS), emphasised that PCSs have the potential to transform and reform port 'business as usual', but she also highlighted several trends that could impact PCS implementation and operation. The issue of cyber-resilience must be addressed by PCS operators, port authorities and all members of the port community; new trade routes and supply chain logistics will significantly shape how trade, and related data, flows; legislation and political buy-in are key in facilitating the change management aspect of PCSs and will continue to influence the future of PCS implementation and operation, she said.

Climate resilience was a major focus area. Swoboda noted that PCSs reduce time and costs, especially as they relate to the duration of cargo vessels in port. This can significantly lower emissions – in some instances, PCSs have contributed to a more than 80% reduction of CO2 emissions in a port.

PORTNET Morocco facilitates trade by optimising logistics and streamlining procedures both within and beyond port operations. CEO Youssef Ahouzi explained how PORTNET enhances transparency, minimises administrative complexities and expedites clearance processes through an integrated approach. In the face of increasing global trade challenges, he said PORTNET's focus on innovation and digital transformation underscored the vital role of PCSs in enabling secure and resilient port ecosystems.

Vineet Malhotra, Co-Founder and Director of Kale Logistics Solutions in India, noted how, by breaking down silos, PCSs foster a culture of cooperation and shared responsibility, generate collaboration which makes it easier to address security concerns and operational challenges quickly, and simplify the implementation of regulatory and compliance requirements by embedding them into systems.

And the advances keep on coming. AI-powered Port Community Systems are already playing a pivotal role in ensuring maritime cargo security through enhanced risk management, automated surveillance, anomaly detection and real-time monitoring of ports and shipyards.

As Port of Los Angeles Executive Director Gene Seroka pointed out, supply chain visibility is no longer the only goal of digitalisation – instead, it serves as a crucial tool that empowers port users to make informed decisions and manage the complex movement of cargo from origin to destination. LA's Port Optimizer digital platform transformed the port's operations by extending cargo flow visibility to an impressive three-week outlook.

When it comes to enabling and optimising streamlined supply chains, the roles played by Port Community Systems continue to evolve and expand – and that will remain the case as we move forward.

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STEPHEN McCOMBIE

Cyber threats to the global maritime transportation system

Expert article • 3745

With the global rise in attacks by cyber threat actors, we now see the deliberate targeting of critical infrastructure. This has been particularly evident in the lead-up and conduct of Russia's invasion of Ukraine where both sides in that conflict have significant capability and have used it. This proliferation is concerning due to the potential for a serious impact on the global economy and security. This is particularly evident within the Global Maritime Transportation System (GMTS). The GMTS is a system of systems that includes not just vessels but also waterways, ports, and land-side connections, moving people and goods to and from the water. The role of GMTS in the global economy is significant with over 80% of the world's cargo transported by ship at the same time fleets are ageing and their technology is ageing with them.

In a 2019 report 'Shen attack: Cyber risk in Asia Pacific ports' – produced by the University of Cambridge Centre for Risk Studies, researchers described a hypothetical cyber-attack across the Asia Pacific against 15 ports using malware that jumped from ships to ports. They projected the loss could go as high as USD$110 billion. While we have not seen a cyber-attack of that size the well-known case of Maersk which lost over USD$300 million in 2017 in the NotPetya malware attack is a noteworthy example.

To get some context of what a major cyber-attack on the GMTS might look like we can look at non-cyber incidents which actually could be easily caused by a cyber-attack. For example, in 2021 the MV Evergiven blocked the Suez Canal and caused major disruption. The incident caused losses of some USD$9 billion per day during the blockage. Similarly, in 2024 the MV Dali collided with the Francis Scott Key Bridge in Baltimore collapsing it and killing 6 workers. Greater loss of life was prevented due to quick action by port authorities. The collapse blocked the harbour and caused significant second-order impacts. Bruce Carnegie-Brown the chair of Lloyd's of London said it was "potentially the largest-ever marine insured loss" as high as USD$4 billion. Such incidents could easily be caused by a cyber-attack. The aim of such an attack might be a part of a great power conflict (i.e., USA/China), a regional conflict (i.e., Israel/Iran), or cybercriminals demanding ransom or shorting the stock market.

As an initiative to enhance awareness of these cyber threats a publicly available Maritime Cyber Attack Database (MCAD) has been developed by our Maritime IT Security research group at NHL Stenden. MCAD spans from 2001 to 2023 (currently collecting 2024) and includes over 290 discrete maritime cybersecurity incidents. These incidents involve 54 countries and over 50 vessels, in addition to various GMTS-associated entities such as ports, shipping companies etc. The attribution of these incidents points to a range of known nation-state and criminal threat actors. Before 2016, threat actors originating in Asia (primarily China and North Korea) were responsible for the majority of incidents studied, while from 2016 onward, Russian threat actors assumed an outsize role. The frequency of cybersecurity incidents targeting the GMTS has steadily increased since 2001 and then significantly increased in 2022 and 2023. Ransomware also increased significantly in those years and comprises over half (53%) of incidents.

Apart from traditional cyber-attacks such as destructive malware and ransomware, the maritime sector is uniquely vulnerable to attacks on its navigation systems. The jamming and spoofing (sending of erroneous locations) of global navigation satellite systems (GNSS), such as the commonly used GPS and the Automatic Identification System (AIS) used in the maritime sector, is now widespread. In 2019 a GPS spoofing attack was used by the Iranian Revolutionary Guard to lure a British ship the Stena Impero into Iranian waters so they could board it. M16 and GCHQ were reportedly investigating if Russia may have provided technical assistance in this incident. In 2021 two NATO warships visiting the Ukrainian port of Odessa had their Automatic Identification System (AIS) signals spoofed showing them travelling from Odessa into the Russian Navy base at Sebastopol. In fact, they never left the wharf in Odessa, but it is believed Russian military Intelligence (GRU) sent these false signals as a provocation. This was not an isolated incident with other NATO ships similarly having their AIS signals spoofed in the Baltic and Atlantic in 2020 and 2021.

While generic cyber hygiene (i.e. desktop protection, network security and patching) is important, good threat intelligence is needed. With that knowledge, organisations can ensure they a prepared for likely attacks and ultimately the inevitable breaches that will occur. This can be achieved with a combination of threat-focused defensive and monitoring measures with regular and comprehensive cyber exercises.

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Progress in shipping only communities can achieve

Expert article • 3746

Global supply chains and logistics continue to face many challenges. Much of this is caused by limited access to reliable data, essential for effectively managing disruptions and accurately calculating emissions. The challenge is twofold: On the one hand, actors lack reliable data, and on the other hand, they are reluctant to share data. The answer to the challenge is a data-sharing community.

One recently established community is the VWT (virtualwatchtower.org) community. The solution backed by neutral research institutes was designed as a public good to overcome traditional fears around data sharing, like the potential exploitation of shared data. Launched in 2023, the VWT members selected two use cases to work on: disruption management and carbon dioxide (CO2) footprint calculations. In the last two years, the group has worked on gathering primary data for disruption management. The next step is to improve the primary data.

So far, the progress is promising. The community has monitored about 250 shipments from October 2024 until January 2025, generating approximately 20,000 datasets. This was possible with the help of Transporeon, a Trimble company, and IOTA, which provided its TWIN architecture. This article is about the findings and next steps of this community project.

A community of collaborative partners

VWT fosters a culture of collaboration. The community comprises leading shippers, transportation companies, and terminals. Leading technology providers, like Transporeon, Fujitsu, Descartes, Infor Nexus, and IOTA, joined the community to help advance the work towards the shared vision. The neutral backers, RISE, VTT, TalTech, and A*STAR's IHPC, exemplify neutrality, competence, and strong governance (Figure 1).

Since 2023, VWT has run 15 bi-monthly community meetings, 21 monthly living lab sessions, and many dedicated workshops and working sessions. Weekly newsflashes keep the members informed. The VWT is regularly showcased at international events, including Nor-Shipping, Singapore Maritime Week, and LogiSYM. VWT regularly disseminates its work and progress in trade press and media.

Co-creating a bespoke solution

In April 2024, VWT demoed Prototype #1 based on real-life container shipments, thanks to data from engaged shippers like Stora Enso and Alleima and contributions from technology providers like Transporeon and Fujitsu.

VWT has started testing the TWIN infrastructure, a state-of-the-art distributed ledger technology-based platform designed for digital data sharing in a decentralized and federated environment. TWIN powers VWTnet, VWT's digital backbone. Through VWTnet, data is shared and turned into itineraries of the shipments monitored. The accuracy results from the focus on primary data.

A community approach to data accuracy

In 2025, the community has started to discuss new features. Roambee, a California-based supply chain intelligence provider and community member, contributed the idea of a lane risk indicator. A lane is a specific route for cargo movement, e.g., "Shenzhen Port to Long Beach Terminal". Lane risk can be assessed by analyzing real-time shipping data and historical data about disruptions as the basis for calculating a single risk score to quickly identify potential delays of goods. VWT partners share real-time data with VWT, allowing algorithms to estimate the likelihood of disruption. In a feedback loop, users validate or flag anomalies.

Figure 1. The VWT community as of January 2025

A 'lookup' feature could enable shippers to see risk scores for chosen routes, aggregated tracking data, and lane health indicators. Publicly displaying information increases confidence in data accuracy as users can suggest corrections and add new lanes, improving data reliability and trust in the approach. This approach creates immediate value through lane risk scores, which are visible without integration. The presence of real-time sensors, sensor-reported data validation of stoppage trends, and detection of subsequent anomalies can further enhance the lane risk model.

The iterative improvements enhance data quality, which leads to more adoptions and trust in API connections, and the community grows naturally.

The network effect

The more members work on co-creating their solutions, the better they become, attracting, in turn, more members. Beyond the network effect, members recruit members: shippers bring their supply chain partners, forwarders, and carriers their shippers, and terminals, the carriers that use their infrastructure, to the community. The technology providers that help build and further VWTnet invite their customers to VWT.

Improved data accuracy through increased data sharing provides supply chain actors a basis for better decision-making. It enhances the capabilities of transport and freight management systems and platforms connected to VWTnet.

Closing remarks

The VWT community aims to build global transport's most widely used primary data-sharing tool. VWTnet is scheduled to go live in 2025, creating the foundation for widespread adoption to expand the VWT member base from 50 to 300. This will only be possible through a collaborative approach to community growth.

VWT, piloted by leading global supply chain community actors and orchestrated by national research institutes, offers a unique collaborative space for shippers, transport and terminal operators, technology providers, and researchers. Together, they are developing the technological capabilities required for a new supply chain and logistics era. The digital age requires collaboration, which opens the route to more community building. VWT sets a new precedent for sustainable, efficient, and resilient global supply chains by fostering collaboration and innovation to address common challenges.

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The European Union and maritime safety and security

Expert article • 3747

The European Union, like the North Atlantic Treaty Organisation (NATO), is interested in actively shaping maritime safety and security. An example of this growing interest was the adoption of the EUMSS – European Union Maritime Security Strategy, in 2014, followed by its revised version and action plan in October 2023. The document contained six strategic objectives, which were translated into some 150 definitive actions formulated in an accompanying action plan. In the light of the objectives adopted, the European Union commits itself, among other things, to intensifying its actions at sea (organising joint exercises between the navies and coastguards of the Member States, stepping up action against threats at sea), cooperating with partners (primarily NATO) or developing civilian and military capabilities in the field of maritime security. However, it is important to recognise that any kind of action taken by the EU will always depend on the political will of the Member States. The EU is an international organisation, not a state, and therefore its capabilities should not be seen as the simple sum of the capabilities of the Member States. The EU does not have its own navy and, as in the case of NATO, the forces allocated to it by the Member States depend on their voluntary declarations and therefore de facto on their interests.

It is worth noting here that the EU's maritime engagement should be viewed in two ways. Firstly, from the perspective of maritime safety, i.e. activities related to the safety of economic activities at sea and non-intentional threats, and secondly, from the perspective of maritime security, i.e. protection against intentional man-made threats (e.g. piracy, maritime terrorism, illegal immigration). These activities are implemented within the framework of the EU's Common Security and Defence Policy. In a literary sense, the terms maritime security and maritime safety are often mentioned as two elements of the same whole, closely correlated, but nevertheless concepts that should be distinguished from each other. This division is very important, as it affects the functioning of many actors, their competences and tasks.

In this respect, it can be concluded that both the Integrated Maritime Policy and the Improvement of Safety in Maritime Transport, in other words the improvement of the safety of human activities at sea (maritime safety), are undoubtedly successes of the EU. The implementation of a number of measures in this area confirms that the EU is becoming an increasingly proactive actor in the maritime environment and that its efforts are recognised globally. A somewhat different aspect of the EU's approach to maritime affairs is the actions taken under the EU's Common Security and Defence Policy (CSDP), which is an integral part of the Common Foreign and Security Policy (CFSP). These actions against intentional man-made threats are undertaken under policies that are intergovernmental in nature. This results in a number of constraints and a constant clash between the supranational factor and the national factor, while imposing a permanent need to seek compromise. The most visible maritime activity conducted under the EU's Common Security and Defence Policy remains military naval operations. However, while EU NAVFOR Atalanta is one of the few unquestionable successes of the EU in the military dimension, other operations, such as EU NAVFOR MED Irini, have limited effectiveness and are characterised by the execution of typically police-like tasks with low combat intensity.

An important attempt to break this approach is the EU's latest naval military operation, the European Union Naval Force (EUNAVFOR) ASPIDES, which aims to ensure security in the Red Sea and the Persian Gulf. It was launched as a direct result of attacks by Yemeni Houthi rebels on merchant ships in the Red Sea.

Although the EU's actions are limited to maritime operations, which de facto mainly protect merchant ships, and do not really neutralise the sources of danger in the area, they do make a significant contribution to the stability and security of shipping and thus to the European maritime economy.

The actions carried out should therefore be seen as unambiguously positive and as an example of the proper use of the EU's potential. They are an example of an exemplification of the growing awareness among EU decision-makers of the close link between the state of the EU economy and the safety of maritime trade routes, and an important signal from the EU, which wishes to be perceived as a global provider of activities not only in the area of maritime safety, but also in the field of maritime security.

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Shipping governance in the Baltic Sea

Expert article • 3748

The governance of anything is messy exemplified by the countless attempts at definition and the failure to reach a satisfactory conclusion; maritime governance is even messier than most and the Baltic Sea is no exception. In fact in some ways it is a prime example of the difficulties that maritime governance presents to policy-makers, institutions, enforcers and clients from the shipping sector. To understand why it is such a complex process we can break it down to a series of constituent parts which, whilst not always being precent, together illustrate its complex structure and point the way towards the most effective solution.

A definition of maritime governance is made complex by the multiple and diverse factors, contexts and actors that are present. However sufficient for our purposes:

"Governance refers, therefore, to all processes of governing, whether undertaken by a government, market, or network, whether over a family, tribe, formal or informal organization, or territory, and whether through laws, norms, power or language. Governance differs from government in that it focuses less on the state and its institutions and more on social practices and activities." Bevir (2012)[1].

It is important to recognise that it is not the same as government but subsumes government within it. In many ways it is all-embracing and includes all the influences in the shipping industry of clients, owners, the entire supply chain, environment, social, technical and political issues and much more. And this makes its understanding, design and organisation that much more complex as well as factors such as globalisation, multiple ownerships, boundaries, territories and nation-states, public goods and ill-defined jurisdictions each having a significant effect.

The governance of shipping in the Baltic Sea area is made even more complex than most because of its multiplicity of national jurisdictions, its complex political context, its environmental sensitivity and its central role in global trades.

Shipping governance everywhere has a large number of drivers that stimulate the need for an effective structure, and which often contradict and are exacerbated by the inherent mobility of the industry in terms of labour, finance, ownership and cargo and exemplified by the variety of vessel registrations many of which bear no relation to the vessel, trade, cargo, crew, management or ownership. These vary with location but might include:

- the need to contain monopoly power (conferences, cartels)
- the need to control excessive and destructive competition
- the complexities of public goods (sea, shoreline, air, views) and the absence of clear ownership boundaries
- the tendency for very long payback periods vessels, ports)
- the high cost of infrastructure (vessels, ports)
- the need for integration and coordination across national boundaries for supply chains
- the role of prestige, influence and international representation (flag choice, IMO, local politics)
- commercial profit versus social good
- tradition (highly significant to national shipping policies)
- employment (less important than commonly recognised; the role of third world flags and crews)
- defence (the role of merchant shipping as support vessels; the need to sustain supply chain security)
- security (terrorism, piracy)
- illegal cargoes (drugs, arms, embargoed materials)
- illegal immigration
- the importance of capital mobility (shipping as a vehicle for financial mobility and money laundering)
- labour mobility (almost infinite across vessel flag choice)
- technical conformity (the example of containers)
- the rise in global shipping businesses, transit and sovereignty
- problems of contradictions between global (UN IMO) and national sovereignty

An analytical framework for shipping governance is widely agreed to consist of a number of elements. Clearly the precise nature of each of these varies with location and context but still provides a sound basis to understand shipping governance in the Baltic Sea.

The most significant of them is that of jurisdiction. Shipping exhibits a range of jurisdictional platforms which correspond to the scale of governance that is under examination. Commonly these are viewed as pyramidal shape with global at the top, and under which lie in turn the supranational (for example the EU, ASEAN), national (USA, India, Japan, UK etc), regional, (Noord Brabant, Scotland, Tasmania) local the ports of Marseille-Fos, Felixstowe, Kobe) and culminating in the body (seafarer, societal individual, swimmer, fishing personnel). In theory this structure provides a mechanism for policy decisions for the shipping industry to be decided at the highest level, encompassing a broad understanding of the needs of the sector, which then trace down the pyramid with each successive layer taking the principles derived above and applying specific detail needed at the different scales and finally arriving at an impact upon the individual body. Thus the UN IMO might discuss global warming and shipping, derive principles that are accepted, adapted and applied by the EU and then passed on to member states to do the same at national level. Regional and local policy would then follow becoming increasingly detailed settling finally at the individual. Feedback would occur at all levels resulting in policy adjustment. All manner of shipping related issues can be considered in this way including their integration.

Vertical governance presents problems. National jurisdiction remains the most significant in that it dominates the structure at global (UN) and supranational (e.g. EU) levels. This means that global policy institutions have no formal or meaningful jurisdiction over that on the nation-state, thus confusing, if not destroying, the vertical pyramidal process. This is exemplified by the difficulties faced by the IMO over environmental policy which is slow and often although agreed by the nation members, may remain domestically unenacted. A major feature of governance in all sectors but especially one as international as shipping, is this national/global conflict exemplified by the abuse of vessel registration, the predominance of flagging out, and the opportunities for policy (and governance) avoidance.

1 *Bevir, M. (2012) Governance; A Very Short Introduction, Oxford University Press: Oxford.*

Shipping governance is also characterised by objectives. These include ambitions for sector efficiency (e.g. to control monopoly abuse and destructive competition); to protect the environment; to increase shipping safety and security of labour, cargoes and vessels; to promote national development (through incentives, subsidies ad collaboration); to improve social conditions (though seafarer training and welfare, cargo, port investment and routing support); and a range of specifically international, cross border issues where the Baltic Sea, with its multitude of national interests, presents a good example. Others issues presenting significant governance problems include transit though the Bosporus, Panama and Suez Canals, the English Channel and much of the Mediterranean ad Black Seas.

However, governance requires policy implementation, and objectives alone are not enough, and to achieve this needs instruments. These include the very common measures in shipping of state intervention through ownership, regulation, promotion and financial support. Commercial regulation is an alternative and one pursued by many m=national governments including those with direct interests in the Baltic Sea. It might involve direct and legally enforceable rules for training, technical standards and inspections, encouragement for shipping companies to operate in certain ways through financial incentives or publicity, direct fiscal measures such as tax incentives typified by the very common tonnage taxes of EU members, and even industrial self-regulation although this latter approach relies upon a disciplined sector and one with some principles which in a commercial environment can sometimes be lacking.

Shipping governance is still not quite complete in its formulation as even though the jurisdictional challenges might be clear, the objectives largely agreed and the methods to achieve them accepted, there still has to be an organisation to deliver them - the agencies.

Agencies delivering shipping policy can be varied in size, operation and structure but commonly include government related departments implementing legislation, incentives and advice, for example, national ministries, UN organisations (IMO, UNCTAD), local and regional government institutions. Common today are also quasi-autonomous non-governmental institutions (QUANGOs) which have close relationships to governments of all types and levels but considerably more independence. However they are often far-from entirely independent characterised by state appointments and funding and thus susceptible to political pressures. They are also almost wholly undemocratic unlike ministries which at least have some democratic credentials - although at times very loosely defined. This is also an issue with institutions such as those of the UN where democratic control is so far removed as to be almost non-existent.

Hybrid state ownership is also an alternative agency with, for example, shipping companies and port authorities jointly owned by the state and by private sector interests, hopefully providing the best of both worlds - democratic representation and commercial acumen. Finally there is entirely self-regulated trade such as that exemplified by BIMCO, International Chamber of Shipping, InterCargo, IACS and many more. They rely upon a combination of loyalty and pride as well as the commercial incentives stemming from retaining a good reputation. This latter characteristic, whilst significant, has been eroded in shipping governance by practices such as widespread flag-hopping, and the complex nature of the structure of the shipping industry, its global activity and the jurisdictional inadequacies of policy-making for inherently mobile activity.

How can the deficiencies in shipping governance be addressed given the domination of the national model operating within a global industry where national boundaries can be, and are, readily abused by the shipping industry, and their importance emphasised or ignored whenever it proves convenient. Some suggestions include improvements in policing and enforcement of regulations which have been adopted. This is obviously not easy as it requires a process of global policing raising issues of varied standards and interpretations, and a diverse legislative base stemming from the requirement for national legal acceptance and interpretation.

Shipping governance is also made more accurate if it is applied at limited points rather than in a general fashion. Specificity along with simplicity are both attributes making application more directed and easier to understand and enforce. Preferable also is commitment by the industry, something that has been sorely lacking in many commercial quarters to date in particular in relation to governance of standards and their application and the impact of the national/global interface.

That leaves us to what remains to be done and much of this relates to all shipping activities across the globe. In particular the industry remains highly nation-state dominated and so in the Baltic Sea, the differing objectives and political and financial pressures that exist across the adjacent nations, all of which have responsibilities and ambitions for their territorial waters and the overlaps that inevitably exist between them, remains a serious governance deficiency. The fiercely commercial nature of shipping and its diverse national interests, many of which bear no relationship to the Baltic Sea yet operate there, makes this difficult. The industry also remains institutionally constipated with representatives from the shipping industry in the governance process surprisingly few and mainly traditional. This is mirrored by conservatively defined stakeholders with poor representation from other industries, social communities and individuals. This in turn is reflected in. the domination that shipowners hold in the policy-making and governance process. And finally, governance remains static, reflecting single point problems with few opportunities to migrate and adapt policies despite the industry itself characterised by movement and change.

The Baltic Sea is an ideal location to see many of these issues on show, and also an ideal location for governance development to be analysed.

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PIIA KARJALAINEN

The Baltic Sea as a maritime hub for passenger transport and tourism

Expert article • 3749

The Baltic Sea boasts one of the most frequent passenger shipping networks in the world and the region is among the busiest maritime areas globally. The maritime connections between the Baltic Sea countries have significantly shaped the economic and cultural development of the region as its coastal states are relatively sparsely populated and difficult to access. The Baltic Sea both unites and separates the states with its coastline.

Maritime transport stands out as an energy-efficient mode of travel, emitting significantly less carbon dioxide per passenger than air transport, particularly over short and medium distances. Many shipping companies operating in the Baltic Sea region have invested in fuel-efficient vessels and innovative technologies such as LNG fuel and hybrid systems to minimise emissions. The region's designation as a Sulfur Emission Control Area (SECA) has pushed for cleaner fuel.

However, the maritime industry globally faces growing pressure to adopt even cleaner technologies, such as electric ships and renewable energy-based solutions. The prospects include transition to fully electrified maritime transport, particularly between short routes like Helsinki-Tallinn. Investments in port infrastructure, including the installation of onshore power supply and construction of charging stations for logistics operators, aim to advance greener transport and help the Baltic Sea maintain its high environmental standards.

Maritime transport significantly contributes to the Baltic Sea region's economy, through regular interconnecting ferry connections and cruise tourism. Passenger ferries and cruise ships bring millions of travelers annually to major port cities like Helsinki, Stockholm, and Tallinn, injecting billions into local economies, and only few people know that the ports of Helsinki and Stockholm are among the busiest passenger ports in the world. The visitors support sectors such as accommodation, dining, and retail in port-cities. Moreover, maritime transport provides direct and indirect employment opportunities in ports, shipping companies, and tourism services.

The Baltic Sea, celebrated for its natural beauty and historical landmarks, has firmly established itself as a thriving hub for maritime tourism. The region connects vibrant capitals, picturesque islands, and historic port cities through a well-organised network of ferry and cruise routes. In 2019, the Baltic Sea reached a significant milestone by welcoming a record 6 million cruise passengers, underscoring its immense popularity among travelers. The COVID-19 pandemic disrupted the strong upward trajectory, and the cruise passenger numbers are still slowly returning to normality. The number of cruise passengers is still relatively low compared to the passengers in ferry services: in 2019, the region had a record value of 120 million ferry passengers. The figures dived during the pandemic but have recovered to 93 million passengers by 2022.

The Baltic Sea's well-developed infrastructure and exotic Nordic location present substantial opportunities for further growth in tourism. By introducing new itineraries to less-explored destinations, the region can distribute economic benefits more evenly and alleviate congestion in its most popular destinations. Addressing seasonality by developing year-round tourism products, such as winter-themed activities or off-season cultural events, would allow the Baltic Sea region to sustain a steady flow of visitors throughout the year.

Yet, more can be done to position the Baltic Sea region as a global leader in maritime tourism. Focusing on eco-tourism is one critical step. In 2024, Helsinki was recognised as the world's most sustainable travel destination by The Global Destination Sustainability Index. Promoting the maritime transport options as a competitive alternative for the incoming tourists could bring the cities' green endeavours to the next level. Establishing carbon-neutral cruises and green-certified ports will appeal to the sustainability-minded travelers. Developing curated shore excursions that highlight historical, culinary, and natural attractions can provide passengers with a deeper connection to the destinations they visit – and give a reason to visit the region again and again. Additionally, investing in year-round attractions, such as winter cruises, Christmas markets, and indoor cultural events, will address seasonality and ensure a steady flow of tourists throughout the year.

Maritime transport and tourism are pillars of economic and social integration in the Baltic Sea region. By embracing sustainability, leveraging our cultural heritage and wonders of nature, and investing in services, the region can enhance its global appeal. The trends are on our side as the studies expect increasing tourism demand for the central and northern regions in Europe, as the consequence of the extreme temperatures in the Mediterranean caused by climate change.

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The volatile seascape in the Baltic Sea

Expert article • 3750

The Baltic Sea has been, is, and will remain a vital corridor for the transport of goods and passengers. Beneath its surface, it also serves as a crucial conduit for data and energy transmission for the countries surrounding it. Since early 2022, however, the region's "business as usual" trajectory has deteriorated into a state of growing instability and unpredictability.

As the youngest sea on Earth, the Baltic Sea spans slightly less than 400,000 km^2, making it only marginally smaller than the Black Sea. It sees approximately 100,000 merchant vessel movements annually, with cargo volumes to, from, and within the Baltic accounting for about 10% of global maritime trade. Furthermore, with around 70 million cross-border passengers each year, the Baltic ranks among the busiest seas globally. Normally, it also accommodates millions of cruise passengers.

Now the era of "normality" has ended, at least for the time being. Dissatisfied with the sanctions imposed by Western countries on itself and Belarus, Russia appears intent on reshaping the rules of maritime and shipping practices. For over 30 years, these rules were underpinned by peaceful coexistence and multilateral agreements, such as the globally recognized UNCLOS (United Nations Convention on the Law of the Sea). However, it has become evident that UNCLOS provisions did not anticipate a scenario where a major signatory—here, Russia—would deliberately seek to circumvent these rules.

The reliance on the Baltic Sea for trade and transport varies significantly among the coastal states. This dependency relies on each country's trade composition, trading partners, and geographical location. Geography plays a crucial role here, as it determines the availability of alternative transport routes.

After 2022, the volume of seaborne trade in all EU Member States along the Baltic Sea - par Poland - ¬ has diminished by 15-30%, while that of Russia and Poland has increased by 20-30%. For most EU Member States, this partly reflects diminishing trade demand, but the direct and indirect effects of sanctions on Russia are the main culprit for these reductions.

In 2023, Finnish and Swedish Baltic Sea ports each handled approximately 90 million tonnes (MT) of cargo. Latvian and Lithuanian seaports managed about 40 MT each, while Estonian ports handled 25 MT. Transit volumes of Russian raw materials have plummeted since 2022, dealing a particularly severe blow to the Baltic States and Finland. For instance, Estonian ports handled around 35 MT in 2022, with approximately 40% consisting of Russian transit cargo. By 2023, their total turnover had fallen to about 23 MT.

Among the Baltic Sea coastal states, Finland is the most reliant on maritime trade. In 2023 and 2024, over 95% of Finland's trade by volume was transported by sea. Land connections through Sweden and Norway, located over 700 kilometres north of Finland's primary seaports, cannot substitute maritime transport, nor do they possess the physical capacity to handle such volumes. Despite these challenges, Finnish businesses have shown exceptional resilience and adaptability in their trade logistics. Since 2022, nearly 30 MT of trade—roughly 30% of Finland's total—have been rearranged or sourced from alternative suppliers.

The three Baltic States are also heavily dependent on maritime connections, though they benefit from direct road access to continental Europe, despite the rail gauge differing at the Polish border. Sweden, on the other hand, relies less on the Baltic Sea for its trade. Its primary port, Gothenburg, is located on the North Sea side and handled approximately 40 MT in 2023. Sweden also has land connections with Norway, a bridge linking it to Denmark, and several short-sea shipping routes with its major European trading partners. Overall, just over 50% of Sweden's trade by volume is conducted via the Baltic Sea.

Poland's sole coastline lies along the Baltic Sea, and its key port, Gdańsk, handles approximately 80 MT of cargo annually. Since 2022, Gdańsk has increased its volume by over 25%. Meanwhile, the combined ports of Gdynia and Szczecin-Świnoujście handle about 60 MT, though their throughput has slightly decreased. Poland's robust land connections with its neighbours provide multiple trade options, supplementing its maritime capabilities. Denmark and Germany are the least reliant on the Baltic Sea among coastal states for trade connections, yet the Baltic remains an important linkage for both nations.

Despite sanctions and the price cap on its crude oil exports, Russia has managed to increase its fossil fuel shipments in recent years. An estimated 150 MT of Russian crude oil (about two-thirds of its total crude oil exports) were transported across the Baltic Sea in 2024, representing a critical revenue stream for a nation at war. Additionally, Russia relies heavily on the Baltic Sea for other major exports, such as non-sanctioned LNG, and for the majority of imports destined for western Russia, including Moscow, St. Petersburg, and surrounding regions. The strategic significance of the Baltic Sea is further highlighted by the fact that, aside from air transport, the only effective supply route between mainland Russia and Kaliningrad is via sea. This vital shipping line is operated by a company owned by Russia's Ministry of Defence.

Given this context, it is perplexing that Russia appears willing to intensify uncertainty through its shipping practices, particularly by relying on the so-called shadow fleet on a large scale. These arrangements deliberately obscure the true ownership, operation, and beneficiaries of the vessels, routes, and cargoes. The actual insurance coverage for these vessels in the event of a maritime accident—along with the potential for widespread environmental damage—may effectively be non-existent. In addition, Russia extensively disrupts satellite navigation across the region, significantly impacting the safety of transport.

The repeated attacks on underwater telecommunications and energy infrastructure in the Baltic Sea since November 2023 can no longer be dismissed as mere accidents. These incidents have targeted telecom cables between Sweden and Estonia, as well as gas and telecom cables between Estonia and Finland. As is typical of asymmetrical hybrid operations, attribution is highly challenging, while denial remains remarkably simple. Even with evidence that goes beyond circumstantial, identifying the perpetrators or masterminds behind these acts is difficult—and holding them accountable is even more so.

One of the most recent incidents in this series occurred on Christmas Day 2024, when an electric cable between Finland and Estonia was severed by the MS *Eagle* S, a tanker under the Cook Islands flag. Finnish authorities boarded the vessel and brought it to a Finnish port, where prosecutors are now preparing criminal charges. During a Port State Control inspection, the vessel was found to have 32 deficiencies, three of which were so severe that it was deemed unfit to sail. The detention of the tanker and its cargo—approximately 35,000 tonnes of petrol valued at around €20 million—sends a strong message and serves as a measure to deter similar actions in the future.

On January 11, 2025, a tanker flagged in Panama and carrying approximately 99,000 tonnes of Russian crude oil lost power and steering. The vessel, part of Russia's shadow fleet, was adrift in Germany's coastal waters north of the island of Rügen. Three tugboats eventually secured the tanker, which was deemed incapable of manoeuvring. According to German authorities, no oil leaks has been detected.

NATO is intensifying its activities too. On January 14, 2025, a Baltic Sea NATO Allies Summit focused on bolstering regional security. As part of these efforts, NATO is enhancing vigilance in the region through initiatives such as *Baltic Sentry*. These measures are aimed to strengthen deterrence and prevent damage to critical infrastructure.

The operational environment and the safety and security of maritime trade and subsea infrastructure in the Baltic Sea are closely tied to the broader geopolitical climate. Russia's ongoing war in Ukraine remains a key—though not the sole—factor shaping developments in the region. At the time of writing, it appears possible, and unfortunately even likely, that the situation could worsen before it improves.

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Baltic Sea, "Our Ocean, Our Obligation, Our Opportunity"

Expert article • 3751

Part of the title is borrowed from the International Maritime Organization's (IMO) World Maritime Day theme for 2025. This theme "Our Ocean, Our Obligation, Our Opportunity" emphasizes the global importance of oceans. The ocean is indispensable for the continued existence of humanity, as it produces half of the planet's oxygen and provides food, jobs, and recreation for a large portion of the world's population, fostering economic growth. It also regulates the planet's climate by absorbing carbon dioxide and heat, mitigating the impacts of climate change. Protecting the ocean is essential for the well-being and survival of humanity and the stability of Earth's ecosystems. Shipping, as the largest user of ocean space, naturally plays a central role in managing and protecting ocean resources.

Our ocean, our *mare nostrum*, the Baltic Sea, is our opportunity, and it is our obligation to ensure its well-being and prosperity. After last decades of positive development, new threats are emerging while we are still struggling with old challenges. We must act to preserve our sea, fulfil our obligations, and seize the opportunities our beautiful Baltic Sea creates for us. However, our existing methods are no longer sufficient. International agreements, cooperation, and stakeholder-driven sustainability efforts have formed the foundation, but we now urgently need new measures, as these aims and values are no longer universally shared.

It is crucial to assess the applicability of the international legal framework, particularly UNCLOS, in ensuring the protection of navigation safety, the marine environment, and submarine infrastructure. Legal options must be explored to take action against vessels suspected of causing damage. Additionally, we should evaluate the current safety regime, regulations, and systems to determine how they can be further developed to enhance future safety measures. These efforts should aim to protect our sea and prevent both intentional and accidental damage to assets such as submarine infrastructure.

Maritime transport is inherently international, which is why the requirements for vessels engaged in international shipping are primarily based on regulations developed by the International Maritime Organization (IMO). Among the IMO conventions containing technical requirements for ships, the most significant are the SOLAS and MARPOL conventions, which apply to vessels in international traffic.

The primary method of ensuring safety at sea is through compliance with internationally agreed regulations. This is achieved through mandatory periodic surveys conducted on vessels to ensure that their structure, machinery, and equipment comply with safety regulations (SOLAS Convention) and pollution prevention requirements (MARPOL Convention). IMO member states are responsible for conducting these surveys, with the flag state overseeing the process. In practice, classification societies usually carry out these inspections on behalf of the flag state. Following the survey, the shipping company is responsible for maintaining the vessel and its equipment in accordance with convention requirements.

The secondary method of ensuring compliance is through port state control (PSC) inspections, conducted in ports or, in some cases, at anchorages in the territorial waters of the port state. PSC inspections create an international monitoring system where each country inspects foreign vessels visiting its ports. The SOLAS and MARPOL conventions grant port states the right and obligation to conduct these inspections, and the EU also has regulations governing them.

The frequency and scope of a PSC inspection depend on the ship's risk classification. High-risk ships undergo more detailed inspections. If deficiencies are found, the port state control authority, such as Traficom in Finland, may suspend the vessel's operation until the issues are resolved. In severe cases, the ship may be denied port access or expelled, as seen in the Eagle S PSC inspection.

Both flag state surveys and port state control inspections aim to ensure that vessels and their crews comply with international agreements. Additionally, Baltic Sea coastal states have implemented measures to support safe navigation, such as mandatory ship reporting systems, vessel traffic services (VTS), and routing measures, including traffic lanes, separation schemes, deep-water routes, and precautionary areas. Compliance is monitored, and non-compliance is reported. However, as with surveys and inspections, gaps remain, allowing those who wish to ignore safety regulations to do so.

Ships are inspected, their movements monitored, and navigation safety measures provided. Aids to navigation, particularly lighthouses and racons, have guided mariners for centuries. However, with the advent of global satellite positioning (GPS) and the broader Global Navigation Satellite System (GNSS), traditional navigation methods based on visual observations and radar have been overshadowed. Ships are now designed, systems developed, and navigators trained with the assumption that GNSS alone can ensure safe navigation under all conditions. This reliance is problematic, as maritime digitalization—including S-100 products for onboard Electronic Chart Display and Information Systems (ECDIS)—is based on GNSS. The geopolitical situation has exposed the system's vulnerability, highlighting the power of those who disregard international agreements. The standards and regulations for GNSS are agreed upon in the IMO, the International Telecommunication Union (ITU), and the International Maritime Satellite Organization (IMSO).

Last autumn, I stated that maritime safety in the Gulf of Finland was at its weakest since the war due to the shadow fleet and GNSS interference. The risks posed by the shadow fleet are increasing, but the GNSS interference in the Gulf of Finland has somewhat subsided. However, we should not assume that interference will not continue or escalate. The previous interference was self-protective, but deliberate interference in the future could have far more severe consequences.

Threats are becoming more diverse, and future developments are difficult to predict. The current international maritime safety system relies on maritime nations and commercial stakeholders complying with

international regulations. Increasing non-compliance is creating parallel maritime systems, where ships are registered in states that are not IMO members and therefore do not adhere to IMO conventions. Some member states also choose to ignore convention requirements.

The shift away from a rules-based global order is dividing global shipping into two increasingly distinct regimes. While part of the world remains committed to protecting the marine environment and enhancing maritime safety, recognizing the vital role of shipping in society and economic stability, others engage in increasingly reckless behaviour driven by self-interest. In this fragmented reality, fostering international cooperation, setting global standards, and advancing ocean science, efforts led by the United Nations through the IMO, will become ever more challenging.

In January 2025, NATO launched *Baltic Sentry*, a multi-domain vigilance activity designed to enhance maritime situational awareness in the Baltic Sea. This initiative underscores NATO's commitment to safeguarding critical undersea infrastructure and deterring potential threats. While such initiatives are essential, they must be complemented by strengthening and further developing the traditional safety systems described earlier, ensuring they function as effective risk control measures. Additionally, we must make better use of the vast amounts of data already collected through existing systems, while also advancing new capabilities. This responsibility falls on the various authorities tasked with ensuring the safety of the Baltic Sea.

If we fail to act, our commitment to *Our Ocean, Our Obligation, Our Opportunity* will be lost.

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Uncertainty as the nature of maritime transport and logistics: A view of maritime business educator

Expert article • 3752

Two terms in definition and evolution

Maritime transport is composed of two pillars: shipping and port. Maritime logistics has been regarded as the primary means of transporting parts and finished goods (viz., outbound logistics) on a global scale and has recently attracted considerable attention from the general public due to the pandemic and unstable geopolitics. The term 'maritime logistics' was initially defined by my colleague and myself back to 2012, who suggest that, for a better understanding and ultimate definition of the term, the starting point should be to consider the underlying scope and characteristics of the two areas making-up the term (i.e., 'maritime transport' and 'logistics and supply chain management'). On the one hand, *maritime transport* is clearly concerned with the transportation of goods and/or passengers between two seaports by sea; on the other hand, *logistics* is the function responsible for the flow of materials from suppliers into an organization, through operations within the organization and then out to customers. A *supply chain* is composed of a series of activities and organizations that materials (e.g., raw materials and information) move through on their journey from initial suppliers to final customers. *Supply chain management* involves the integration of all key business operations across the supply chain in an effective and efficient way.

Based on these understandings, we took a further step towards the issue of convergence of maritime transport and logistics. These two terms are largely attributed to the physical integration of modes of transport facilitated by containerisation and the evolving demands of end-users that require the application of logistics concepts and the achievement of logistics goals. At the centre of maritime logistics is, therefore, the concept of integration, be it physical (intermodal or multimodal), economic and strategic (vertical integration, governance structure) and/or organizational (relational, people and process integration across organizations). All becomes nowadays ever more digitalised (synchromodality).

Ever changing and volatile business pattern

There have been dramatic changes in the mode of world trade and cargo/freight transportation, characterized by the prevalence of business-to-business and integrated supply chains. These changes have been embodied by the increasing demand for value-added logistics services and the integration of various transportation modes. Consequently, the business stability and economic sustainability of the industry is largely subject to how well it adapts to such a dynamic environment. The high quality of logistics services and the effective and efficient integration of transport systems offered by maritime operators (i.e., shipping companies, port and/or terminal operators) have become an important issue. In other words, globalization and transport revolution, logistics integration, and the consequent expansion of the maritime industry have redefined the functional role of shipping and ports in global logistics and supply chains and have generated a new pattern of freight distribution. In this process, a number of issues still require further consideration, elaboration or explanation.

Maritime business is notorious for its volatility in nature, largely due to the fact that the supply side is clumsy: that is, less-responsive to unexpected demands, and relatively more time to take back to the right track towards a so-called equilibrium between demand and supply. This very nature of volatility becomes even more capricious and unpredictable by the recently experienced pandemic, causing the maritime business world to be exposed to the greater uncertainty. Recent years will be definitely remembered a special or unprecedented incident by human history in terms of scale and impact on every aspect of human life.

Education as a way to prepare ourselves for the future

Adaptability is all about the survival. This is particularly true in the business world including the maritime sector. Throughout the history, indeed, human beings have been all the time seeking out a way to respond to the (un)expected challenges. The historian Arnold Toynbee (1889-1975) describes this phenomenon as a never-ending process of challenges and responses. Those uncertainties could be a *challenge*, in addition to ongoing manifestations over decarbonization and digitalization. Education (learning by ourselves as well as from others) could be regarded as a 'collective' *response* to those (un)expected challenges imposed on every aspect of today's maritime business.

Three reasons could be mentioned here below why a research-based maritime business education becomes imperative at the global level. (i) The fast-moving industry development requires an up-to-dated education and training as a way for professionals to deal with the ever-sophisticated maritime business and operations. (ii) The volatile nature of our industry has not sufficiently made itself resilient against external shocks, let alone its nature of derived demand. (iii) Being a truly global network-based industry, our sector becomes an ever-more interconnected system having engaged with a number of stakeholders from the developing as well as developed world, thus causing a high level of uncertainties even within the system. These are 'some' reasons that maritime business and management education ought to be research-based at the global level.

Here in the World Maritime University (WMU), we are working towards the direction. WMU was founded in 1983 within the framework of the International Maritime Organization, a specialized agency of the United Nations, as its premier centre of excellence for maritime postgraduate education, research, and capacity development. The University offers unique postgraduate educational programmes, undertakes wide-ranging research in maritime and ocean-related studies, and continues maritime

capacity development in line with the UN Sustainable Development Goals. More specifically, the University has been an educational hub for those subjects as *shipping, port management and logistics* since they were offered in 1996. Four different modes of education programmes and services are being offered: (i) MSc in Maritime Affairs with specializations of 'Shipping Management and Logistics' and 'Port Management' based on Malmö, Sweden, (ii) MSc in Maritime Affairs with a specialization of 'International Transport and Logistics' delivered in Shanghai, China by WMU in collaboration with Shanghai Maritime University, (iii) Postgraduate Diploma in Executive Maritime Management, delivered online in association with DNV, the world's largest ship and offshore classification society, and (iv) Executive and Professional Development Courses upon request from any organization in the world (see https://www.wmu.se/programmes for more).

The University's history of nurturing the future leaders in the field of shipping and port management and logistics shows that, as of January 2025 from the Malmö-based programmes, 718 mid-leveled intellectual forces from 99 different countries have been educated and trained. Those students were (and are/will be) taught by qualified academics and experienced professionals under the philosophy that developing critical thinking and data-driven decision-making analytics, and sharing learned knowledge and know-hows with others are of paramount importance.

Closing remark

The Chicago economist Frank Knight (1885-1972) classifies uncertainty into three types: known, unknown and unknowable. Education will equip us to get prepared well for the first type, reasonably for the second, and more elastic than otherwise even for the third.

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Baltic Sea: Grey risks in strategic waters

Expert article • 3753

Over the past two decades, the Baltic Sea has undergone a dramatic transformation. Since the 1990s primarily serving as a shipping corridor, it has evolved into a complex maritime space hosting critical infrastructure that underpins both regional economic development and environmental sustainability. The sea now accommodates expanding offshore wind farms—vital components of the European green energy revolution—and crucial subsea data cables that facilitate international communications and commerce.

However, this infrastructure expansion coincides with mounting environmental challenges. The marine ecosystem faces increasing pressure from shipping-related pollution and the lingering threat of World War II-era munitions. Infrastructure development and environmental concerns have historically been addressed through robust international cooperation, primarily through organizations like the Council of Baltic Sea States (CBSS) and the Helsinki Commission (HELCOM). HELCOM's Baltic Sea Action Plan has been particularly instrumental in coordinating environmental protection efforts and promoting sustainable maritime practices across the region.

The Russian invasion of Ukraine in 2022 disrupted this established framework of regional cooperation. The suspension of CBSS projects marked the beginning of a period characterized by uncertainty and grey-zone conflicts. This new reality was starkly illustrated by a series of mysterious infrastructure incidents starting with the damage to the Nord Stream pipelines in 2022, the sabotage of the Baltic Connector pipelines, as well as cuts of several underwater electricity and communication cables in the region that occurred in autumn 2024.

The implementation of sanctions against Russia's oil trade introduced additional complexities to regional maritime security. The emergence of the "shadow fleet"—aging tankers, often operating without proper insurance—to transport Russian oil has created new safety risks in Baltic waters. This was evidenced by three serious incidents: the engine failures of the Yannis P. and Canis Power in 2023, and a collision involving the Andromeda Star in 2024. These incidents underscored the potential environmental and security threats posed by this development.

In response to these challenges, a new wave of regional cooperation is emerging, albeit with a stronger focus on security. Sweden and Finland's NATO membership has strengthened Nordic defense integration, while Germany has established a new naval NATO headquarters for the Baltic sea. Poland's 2024 proposal for enhanced naval coordination among Baltic states represents another step toward collective maritime security. NATO and the EU have put renewed emphasis on maritime security with a particular focus on underwater infrastructures, information sharing and the coordination of operational responses.

The successful handling of the cable cuts attributed to the Y Peng 3 in November 2024 demonstrated the potential effectiveness of this evolving cooperative framework. However, questions remain about the optimal structure for regional governance. The overlapping mandates of NATO, the EU, and the Baltic Council require careful coordination to avoid institutional conflicts and ensure effective responses to both traditional and emerging maritime challenges.

Looking ahead, the Baltic Sea's stability remains intrinsically linked to the resolution of the Ukraine conflict. The region faces dual imperatives: advancing crucial green energy infrastructure while managing security risks. This tension was evident when security concerns led Sweden to cancel a significant cross-border wind energy infrastructure project, highlighting the complex balance between green economic development and strategic considerations in the current geopolitical environment.

The Baltic Sea's future as a vital economic corridor and green energy hub depends on the region's ability to develop effective mechanisms for protecting critical infrastructure while maintaining environmental standards in an increasingly complex security landscape.

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New aspects of security threat in the Baltic Sea

Expert article • 3754

The Baltic Sea is unique because of its geographical, hydrometeorological, economic, military and political factors. It is an inland, shallow, brackish sea and has some of the busiest shipping routes in the world. There are many underwater and surface maritime critical infrastructure in the Baltic. Since July 2005 the whole Baltic Sea has been covered by AIS which allows real-time monitoring of ships' traffic. The Baltic is approved by IMO as Particularly Sensitive Sea Area. Finally, among Baltic countries only Russia is not the UE and NATO member. It has been the area of confrontation between Russia and other countries for many years.

Hybrid activities are very attractive for Russia because they have very favorable cost-effect ratio. What is more, it is very difficult to attribute a specific entity to responsibility and it is difficult to prove that such action was intentional. According the international law it is not also easy to punish gray zone aggressors.

Hybrid activities can include: unlawful actions against maritime critical infrastructure, cyberattacks on terminals, sabotages in ports, causing an intentional leak of petrol from
a wreck, intentional pollution of the sea, long-term recognition of sea area as unsafe for navigation due to military exercises, intentional turning off the AIS by ships or aircrafts, dangerous maneuvers of Russian ships and aircrafts and GPS jamming.

The threats to the security of shipping in the Baltic have been observed for several years. After the outbreak of the war in Ukraine, Russia has been suspected of numerous actions, classified as hybrid activities, against economic and political interests of countries considered hostile by Russia. These activities are multidimensional and are not limited only to the Baltic Sea. Currently it can be observed that such activities are more and more frequent and are becoming more and more dangerous.

In 2024 several fires took place in many countries in Europe, which turned out to be intentional arsons. The evidence indicates with high probability that they had been caused by GRU officers or saboteurs inspired by the Russian secret services. There were also several strange accidents with underwater fiber and electrical cables. There were at least 10 European underwater cables damaged in the years 2021-2024. The depths at which some of these incidents occurred indicate that damages were intentional and had required specialized equipment for deep-water operations.

Incidents with critical underwater infrastructure in the Baltic Sea show the need to take an immediate and robust action to secure this infrastructure.

The analysis show that the actions against maritime infrastructure in the Baltic Sea will decrease in the coming months. However, the following actions are likely to be intensified: Russian shadow tankers fleet (called also dark fleet) will increase its activities, intentional fuel leakage from wrecks will occur, provocative actions of Russian ships and planes along with declaring area in international waters as dangerous for navigation due to military exercises will become frequent. These actions will create security threats and will force the EU countries to take protective measures. They will not be only military threats, but also non-military threats, generating the involvement of separate forces, which consequently will have a financial effect on EU countries.

The Baltic Sea is the Particularly Sensitive Sea Area and needs special protection because of its significance for recognized ecological and others attributes, which may be vulnerable to damage by international shipping activities. Pollution of the marine environment in the Baltic Sea as a result of intentional actions or accidents are one of the most serious threats. The ships from shadow Russian tankers fleet are very often in poor technical condition. Such ships are serious threats to the environment. To minimize these threats is not easy because of the UNCLOS Convention.

However, the entry or exit from the area is controlled by the EU countries, such ships must enter the territorial waters of Sweden, Denmark and Germany and that allows us to act. There are same rules of the UNCLOS which allow to take actions against the Russian shadow tanker fleet example: art. 39 (2b), art. 42 (1a, 1b), art. 43 (b), art. 194 (1, 2) art. 220 (3, 5, 6) and art. 226 (1a, 1ai, 1bi, 1c).

Russia has been testing the ability to stretch the relations with other countries for many years. The EU countries must define the red line for Russia in the Baltic and clearly indicate the principles of the Baltic deterrence strategy. We must also work out the answer to the question what the EU will allow Russia to do and what will not be allowed and accepted in the Baltic.

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Securing critical infrastructure in the Baltic Sea region

Expert article • 3755

The European Union (EU) Strategy for the Baltic Sea Region has several objectives including connecting the region and increasing prosperity. The EU and the circum-Baltic states have made progress, however Russian Federation political warfare, including the destruction of critical infrastructure and assassinations throughout Europe, now threatens those objectives.

The Baltic Sea has been the center of maritime trade for thousands of years. Regional states continue that tradition, expanding beyond maritime operations to include rail, energy, and communications infrastructure. However, the project remains incomplete and under attack. Regional states, the EU, and other bodies must generate the resources and the political will to finish building and defending this infrastructure.

In December 2024, the US Congressional Helsinki Commission mapped nearly 150 Russian operations since February 2022. They are designed to stay below the threshold that would allow for a military response and are part of the Russian campaign to destabilize Europe to diminish support for Ukraine and undermine organizations like the EU and NATO. Of these operations, some 33% were directed against critical infrastructure and many were focused on the Baltic region.

Maritime transportation infrastructure is very well developed in the Baltic Sea, however, Moscow's large-scale jamming of navigation signals around the region has recently intensified, disrupting air and sea navigation and provoking the ire of the impacted countries. The effects of intermittent jamming by Russian electronic warfare equipment are felt from northern Norway to southern Poland. Additionally, as the 2020 Maersk hacks showed, when Russian hacker group Sandworm released the NotPetya virus into the wild, maritime transportation infrastructure is also vulnerable to cyber operations.

It is impossible, however, to disaggregate maritime infrastructure from other transportation, energy, and communications infrastructure. They are intimately intertwined, under attack, and need protection.

Although Sweden and Norway have rail projects designed to connect the west coast of Norway to the rest of Europe through Sweden, rail projects in the east remain underdeveloped. The EU and the Baltic states still need to finish Rail Baltica to build European-gauge railroads from Poland to Tallinn. The West Railway in Finland is a partly double-tracked rail link between Helsinki and Turku, however Finland, Sweden, the EU and NATO should consider double-tracking the rails from Helsinki to Luleå in Sweden and on to Narvik. This would link Finland to potential reinforcement through either Narvik or Trondheim. They should also consider resourcing the Helsinki-Tallinn railway tunnel, which would allow rail support to the Baltics if the Russians were to close the Suwalki Gap on the Polish/Lithuanian border, and to Finland if the Russians block rail links in central Finland.

Energy and communications infrastructure are well developed and under attack. In late 2024, ships the European Commission identified as being part of "Russia's shadow fleet" cut the Lion1 cable between Finland and Germany, the Balticconnector gas pipeline, two data cables, and the Estlink 2 undersea power cable, all connecting Finland and Estonia.

These operations targeting maritime traffic, communications, and energy infrastructure require that the circum-Baltic states review and update their legal codes to increase the intensity and intrusiveness of their intelligence and police operations, as the Finnish government is doing. They should also examine using military assets in a defensive posture. Since the entire Baltic Sea comprises territorial waters and Exclusive Economic Zones, domestic legal codes and international agreements make these types of security operations legal and appropriate.

Another initiative would be creating a critical infrastructure common operating picture. Some organizations such as the Joint Expeditionary Force and NATO have already activated a system to track threats. Additionally, the EU, local states, and NATO should build resilience into critical infrastructure to minimize the effect of future Russian cyber, electronic warfare, and physical operations on regional critical infrastructure. The EU also needs to update its Baltic Sea Strategy for the Baltic Sea Region; although the objectives remain valid, the geopolitical situation has changed significantly, requiring a fresh approach.

If regional states do not generate resources and political will and focus on critical infrastructure, Russian hybrid operations will generate internal friction and decrease regional economic activity, weakening European states at a critical time.

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SLOC´s under siege

Expert article • 3756

Maritime traffic and critical underwater infrastructure are in the very hotspot in current contested world. The high dependency on transportation of goods, services, information and energy via sea makes SLOC´s a attractive target. From a military point of view the attacks against maritime traffic and hybrid operations against critical underwater infrastructure are a question of sea control. About who is able to use the sea for its own purposes or deny the use from another. This article tries to portray how the lessons drawn from today´s incidents and crisis are addressed to navies.

From pirates to anchors and missiles

Some 15 years ago Somali pirates caused enormous costs to maritime traffic and to the nations allocating units to compel the pirates. The yearly cost caused by piracy peaked in 2011 as 7 billion U$D.

Huthi attacks with drones, anti-surface missiles and sea mines in the Red Sea against maritime traffic have decreased maritime traffic in the area by 60-70 percent.

The attacks against **underwater infrastructure** with dragging anchor and other means are well reported and a form of warfare, where the actor maintains the aggression below the threshold of war.

In **the Black Sea**, Ukraine defending its sovereignty against belligerent Russia, with hardly any warships, has successfully used a large variety of weapons. In 2022 it laid protective sea mines outside its coast, which caused Russia not to execute any major amphibious operations. The use of land-launched surface-to-surface Neptune missiles caused Russian Black Sea Fleets flagship *Moskva* to sink and Russian warships have since kept a healthier distance to Ukrainian coast. Ukraine has destroyed or damaged almost 30 Russian warships with missiles and drones. Some victims have been moving, but majority has been static ships. Ukraine has been able to establish sea lines of communication for its grain export without traditional navy ships, although on lower scale than before the war. Russia has not been able to execute an effective embargo against Ukraine because it has not enough capabilities to protect its own units against drones and missiles. Both sides seem to avoid getting enemies from commercial shipping stakeholders, and therefore are not attacking merchant traffic.

Material costs

Coping the Somali piracy in 2000-2017 required low end set of military and civilian constabulary capabilities. The pirates used small boats, AK-47 and rocket propelled grenade launchers to seize merchant ships. Warships and patrol ships seized several pirate teams and navies also destroyed pirate vessels on the beaches. Merchant ships were mainly safe if they kept higher transit speed in threatening areas and also by having private armed security teams onboard.

In order to maintain an adequate level of sea control, it requires first of all situational awareness and presence, which can be done by warships and maritime patrol aircrafts. **Warship costs.** A corvette costs 400 M€ without missiles, and a frigate 500-1 000 million €. The price tag of a US Arleigh Burke class destroyer is 2 bn US$. The lower end of military units is an offshore patrol vessel, typically 50-100 M€. A ship-based helicopter like MH-60R or NH-90 cost 50-60 M€. **Weapon costs.** At the moment attacking with unmanned aerial vehicles (UAV), like drones, is cheap and the systems are available for anyone. The attacking drones have to be destroyed, and that is not cheap. Israel Navy has used Tamir-missiles. The unit price of the anti-air missile is stated to be in a range of 100 000 – 150 000 U$D. Western frigates and destroyers have launched ESSM, SM-2 and ASTER 15 anti-air missiles, unit price being more than 2 M€. These missiles are also able to intercept anti-surface cruise missiles, which cost 0,5 – 2,5 M€. The most usual naval gun is Leonardo 76 mm gun with a 20 km range. One shot cost a couple thousand € and you might need several bursts of fire. The last trench is a close-in-weapon-system (CIWS). US made Phalanx (12 MUS$) with six 20 mm barrels have a rate of fire of 4500 rounds per minute. A typical burst of 150 rounds is reported to cost 7 000 U$D. **Unmanned surface vessels** (USV) are not as sensitive to a hit as a flying object therefore requiring several hits or bigger caliber gun or a grenade gun.

Laser weapons are assumed as one cost effective solution to engage UAV´s and other low-cost systems. UK Armed Forces Dragonfire laser system is at the moment expensive, 100 M£, but a single shot is claimed to cost only 10 £.

Constant threat consisting of fast, stealth and lethal vectors requires uninterrupted attention, which is strenuous. A long-term deployment calls for at least three watches instead of two, if possible. This means more well-trained personnel, and training takes years.

Conclusions

Some argue the current crisis´s at sea have demonstrated that traditional assets of sea power are obsolete, but that is not true. A wide toolbox with new unmanned systems and traditional systems is required. New systems are the way ahead, but there is still a high demand for sea mines, surface-to-surface missiles, naval guns and surface ships with versatile sensor suite capable of operating for long times in areas of interest. It is impossible to replace the warships protecting the merchant ships against cruise missiles and drones in the Red Sea by any other capability or systems. Protection of SLOC´s requires investments. The SLOC´s are priceless.

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Role of Coast Guards in safeguarding sea lines of communication

Expert article • 3757

Sea lines of communication (SLOCs) are the lifelines of global trade, connecting nations and economies through the maritime transport of goods and resources. Ensuring the safety and security of these vital waterways is paramount for the prosperity and stability of the whole international community and especially for countries like Finland being dependent on fluent functioning of maritime connections. Coast Guard authorities are uniquely positioned to address a wide range of threats and challenges that fall outside the traditional purview of navies as part of military forces. This article summarizes the multifunctional role of Coast Guards in protecting SLOCs by highlighting their unique capabilities and contributions to maritime security and safety.

The evolving maritime security landscape

Maritime domain faces a complex and ever-evolving array of threats, ranging from security threats to safety challenges. These threats and challenges not only disrupt the flow of legitimate trade but also pose significant risks to human life, national security and the marine ecosystem. In this context, Coast Guard authorities have emerged as indispensable authorities in safeguarding common interests. Their diverse missions, extensive maritime domain awareness and a clear role as law enforcement authority enable them to effectively address a wide spectrum of maritime security threats and safety challenges.

Advantages of Coast Guard authorities

Coast Guards possess several advantages that make them uniquely suited for safeguarding SLOCs. Through constant surveillance and intelligence gathering, Coast Guards maintain a comprehensive understanding of activities within their areas of responsibility, enabling proactive responses to potential threats. This maritime domain awareness needs to be considered as a tool or instrument to reach objectives (e.g. to prevent crime and to prevent loss of lives at sea), but not as a goal in itself. Coast Guard authorities are capable of seamless transition between law enforcement and defense roles, providing a flexible and adaptable response to evolving threats. Coast Guard authorities are often able to act in circumstances that do not allow for military authorities' intervention.

Practical example of a highly capable Coast Guard unit is Gulf of Finland Coast Guards District's (part of the Finnish Border Guard) special intervention unit. Its mission profile covers high risk law enforcement tasks, counter terrorism, hostage rescue operations and counter hybrid threats. Gulf of Finland Coast Guard District's special intervention unit is specialized for maritime operations, especially for boarding operations on sea. Among others, the unit has diving, sniper and special boat team capabilities for demanding operations.

It is always worth highlighting that Coast Guards possess a legal authority to enforce maritime laws and regulations, including those related to customs, immigration and marine environmental protection. Coast Guards are well trained and equipped for search and rescue operations, for safeguarding safety of life at sea. Coast Guards play a critical role in protecting the marine environment by combating pollution, enforcing environmental regulations and responding to a large variety of maritime incidents. Coast Guards are able to cooperate with international partners to enhance maritime security capabilities through joint trainings, exercises and information sharing for further improved maritime domain awareness.

Key contributions of Coast Guards in safeguarding SLOCs and safety of maritime domain

Coast Guards play an important role in safeguarding SLOCs through a range of activities. Coast Guards are the first responders to a wide range of maritime incidents, including assistance to vessels in distress, search and rescue operations and pollution response. For maintaining maritime order Coast Guards enforce maritime laws and regulations and thereby contribute to the safety and security of navigation. While doing that, Coast Guards are also promoting compliance with international maritime standards. Coast Guards safeguard vital maritime infrastructure, such as underwater cables, gas pipes and offshore installations, from threats such as sabotage and terrorism. Coast Guards have an important role also in international waters including Exclusive Economic Zone (EEZ). As a practical example, The Finnish Border Guard, which is the leading Coast Guard authority in Finland, is the only competent authority on the Finnish EEZ.

As part of their daily business, Coast Guards are conducting patrols and thereby providing escorts to vessels and maritime traffic. Coast Guards prevent and disrupt criminal networks operating at sea and bring perpetrators to justice. In the maritime domain Coast Guards can also intercept illicit drug shipments, disrupt smuggling networks and thereby contribute to combat drug trafficking.

Topical issues in the current operational environment

In the current security situation, it must always be kept in mind that someone or some country might try to use internationally agreed procedures for own purposes in a wrong way. For example, when receiving a maritime safety related request for a place of refuge for a ship, Coast Guard authorities need to use all the available expertise on what kind of cargo and personnel there is on board of the vessel requesting for a safe harbor. Risk analysis must be updated and thought carefully. If need be, Coast Guard authorities can rapidly perform a shift of activities from safety tasks via law enforcement duties to use of military force.

Conclusion

Coast Guard authorities have an indispensable role in contributing to safeguarding sea lines of communication. Coast Guard authorities´ multifunctional and unique capabilities, extensive maritime domain awareness and law enforcements authority´s executive powers combined with a role in military defense enable Coast Guards to effectively address a wide range of threats and challenges. By investing and empowering Coast Guards, the international community can significantly enhance maritime security, maritime safety and promote sustainable economic development.

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Is Finland's foreign trade sailing the wrong course?

Expert article • 3758

Finland's fairway dues are exceptional in the EU

Finland has traditionally relied on export-driven economy, with maritime logistics playing a key role. Maritime transport is essential, as approximately 96% of foreign trade shipments are carried by sea.

Finland is one of the few countries in the EU that collects fairway dues from vessels, at least on this scale. Fairway dues are levied on vessels engaged in commercial shipping within Finnish territorial waters. Finnish Customs collects these dues, and the state uses the revenue to improve waterways and maintain the Vessel Traffic System (VTS). The fairway due is calculated by multiplying the vessel's net tonnage by the unit price. Cargo and passenger vessels are subject to unit prices determined by their ice class, while cruise ships and high-speed vessels are charged fixed unit prices regardless of ice class. Ice classes 1A Super and 1A have separate unit prices, while ice classes 1B, 1C, 2, and 3 are grouped into shared pricing categories.

The maximum fairway due per vessel call is €94,408 for cargo and high-speed vessels, € 28,414 for passenger vessels, and € 38,990 for cruise ships. Fairway dues for passenger and high-speed vessels are payable for the first 30 vessel calls per calendar year, while for cargo vessels, the dues are payable for the first 10 calls per calendar year.

High fairway dues can hinder Finland's international trade

Fairway dues have been halved since 2015 under temporary legislation. In 2023, the Finnish government signaled in its government program that fairway dues would remain halved at least until 2027, with the reduction possibly becoming permanent. However, 2024 brought a different outcome. On December 19, 2024, the President of Finland ratified an amendment to the Act on Fairway Dues and repealed the temporary fairway dues legislation. The amendment raised unit prices and maximum fairway due amounts by 75.2%. Additionally, the separate discount granted for the transit transport of exports was removed from the legislation. Other aspects of how fairway dues are determined remained unchanged.

The increase in fairway dues is expected to generate approximately €36 million in additional revenue for Finland's state budget. However, compared to the €89.2 billion state budget for 2025, this is a relatively insignificant sum, especially considering its impact on Finland's exports.

The fairway dues increase directly raises transportation costs, which are quickly transferred to the cost structures of industries and trade. Particularly vulnerable are sectors that use large cargo vessels to transport low-margin products, such as raw materials and products in the forest industry. The competitiveness of these sectors relies on cost-effective transportation solutions, and higher fairway dues may weaken their ability to compete internationally.

Moreover, EU emissions regulations impose additional cost pressures on the shipping industry, estimated to increase annual costs by €500–600 million. The hike in fairway dues exacerbates this situation, adding further pressure to industries already squeezed by global competition and high costs.

Fairway dues can have a far-reaching impact in South-Eastern Finland

The impacts of these increases are not evenly distributed, hitting hardest in regions and ports that serve as hubs for export activities. For instance, the Port of Hamina-Kotka, Finland's largest export port, accounts for approximately 30% of all fairway dues.

There are also major investment plans in the same area, such as a battery materials plant, a plant producing renewable methane and hydrogen, and other investments plans in the field of green transition. Increases in fairway dues may not necessarily delay the investments, but other areas and countries are also competing for the same investments, and thus, from an investors' perspective, all additional costs are naturally a negative factor and reduce the attractiveness of the region, especially if transport volumes are large.

From the perspective of a regional higher education institution, new green technologies bring opportunities for both education and RDI activities. An understanding of emerging technologies and their implementation in education and working life are needed as well as new experts on the field. On the flip side, the current geopolitical situation, the relocation of investments, and increased logistics costs affect, for example, students' practical training opportunities and future work prospects, at least on a regional level, but potentially even nationally.

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METO – a unique form of maritime cooperation in Finland

Expert article • 3759

The Baltic Sea is one of the busiest shipping areas in the world. Due to its shallow waters, rugged coastline and icy waters, the Baltic Sea faces constant risks of major accidents and disturbances as well as environmental damage. Recently, the risks have increased all over the Baltic Sea, but especially in the Gulf of Finland. The vessels evading sanctions imposed on Russian oil, disturbances in satellite navigation and anomalies in AIS systems have drastically changed the operating environment – turning the recurrent changes into "a new normal".

The "new normal" emphasizes increased situational awareness: gathering information, analysing it, and making decisions based on it. Maritime surveillance and maritime situational pictures are today more important than ever.

In Finland, maritime situational awareness is produced by The Finnish Navy, The Finnish Border Guard, The Finnish Transport and Communications Agency Traficom and The Finnish Transport Infrastructure Agency. Each organization fulfills different tasks and differ in their operating methods. Administratively, they belong to different administrative branches: Ministry of Defence, Ministry of the Interior, and Ministry of Transport and Communications.

The risk is that the tasks and methods of the four organizations can easily overlap, or that there may be gaps in between. To solve the imminent risk, the four organizations formed a joint organ already 30 years ago. Cooperation of Maritime Operators (METO), founded in 1994, serves three main tasks: increase safety and efficiency, rationalize operations and generate savings.

Already at the beginning, METO parties agreed to create and maintain a joint national maritime situation picture, combining data produced by sensors from all parties (AIS, radar, camera, sense). A joint maritime situational picture together with maritime surveillance have increased the efficiency of maritime operations and saved costs from all parties. Instead of developing four separate systems, it has been possible to not only add but multiply the amount and quality of data from various locations and sensors, incurring savings to all parties.

Over the years, METO parties have arranged numerous multidisciplinary table-top exercises where participants go through different maritime scenarios. Participants actively share information with each other and facilitate the use of resources to eliminate overlapping functions and fill in gaps. As the simulations proceed, participants must at every stage create and share a situational picture, determine who the responsible authority in each situation is, and how to organize and assign roles to parties. Scenario based approach helps all parties to view their own activities from the perspective of other participants, and vice versa, and to identify questions they need to ask within their own organizations. Additional participants (police, vessel traffic services, shipping companies etc) are invited to the exercises, if deemed necessary.

As an outcome of the table-top exercises, the participants define development needs within their own organization and in cooperation with others. The findings are further elaborated, and corrective actions are defined and followed in regular meetings. In case of any findings requiring clarification or adjustment of legal aspects, a message is put forward to respective ministries.

The most recent table-top exercise took place early February, and it consisted of three scenarios, prepared by the Finnish Naval Academy. In addition to four permanent METO parties, The Finnish Customs attended the exercise. The scenarios were based on current topics: hybrid influence, GNSS interference, ship carrying sanctioned cargo, environmental hazards and icebreaking. Participants increased their awareness of each other's roles and operational methods in various legal conditions: normal conditions, exceptional conditions, and state of emergency.

The Finnish METO is a truly unique form of cooperation and could serve as an example to other countries. The results and benefits are convincing, and they have required a lot of work and more importantly, a shared understanding. METO requires mutual trust, will to cooperate, and common task – to promote the best of Finland.

According to the motto, METO is "More than the sum of its parts."

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The role of Finland's maritime technology industry in securing national resilience

Expert article • 3760

The security environment in the Baltic Sea region has changed significantly in recent years, and Finland's geographical position imposes unique demands on its maritime capabilities. With approximately 96% of Finland's imports and exports dependent on shipping, the nation's economy and security of supply are heavily reliant on maritime transport through the Baltic Sea. The security of supply includes ensuring the continuity of essential goods and services, such as food, energy, transportation, health services, and military needs. Finland's ability to maintain uninterrupted access to these is closely linked to its maritime infrastructure.

Finland's long-term preparedness efforts, through collaboration between authorities and businesses, strengthen the nation's resilience. The National Emergency Supply Agency's Maritime Transport Pool supports maritime transport continuity, assisting critical companies with risk management and business continuity training. Finland's maritime technology industry is vital in ensuring the expertise and technological innovations needed for efficient maritime operations.

The Baltic Sea's year-round navigability is essential for trade and defense, and Finland's expertise in icebreaking technology is globally recognized. Finnish shipyards have designed 80% of the world's icebreakers, ensuring access to critical shipping lanes in winter. Icebreakers are central to Finland's economic stability and supply chain resilience. In addition, Finnish marine companies provide advanced systems and solutions for ensuring vessel safety in harsh conditions.

Environmental risks in the Baltic Sea, such as oil spills, further underline the importance of rapid maritime response capabilities. Finland's archipelago and coastline are ecologically valuable, requiring robust measures to prevent environmental damage. The maritime technology industry plays a crucial role in this regard, providing the ships, equipment and expertise needed to mitigate such risks.

Finland's maritime technology sector also strengthens national defense. Finnish shipbuilders collaborate with defense forces to enhance maritime readiness by developing naval vessels and advanced systems. For instance, the Squadron 2020 project will replace decommissioned vessels with modern corvettes, providing crucial naval defense. Similarly, the Finnish Border Guard is enhancing its capabilities with two new multi-purpose patrol vessels equipped with advanced spill response systems.
Cybersecurity is increasingly important as the maritime sector becomes more digitized. Finnish companies lead in developing secure systems to protect critical maritime infrastructure, mitigating emerging cyber threats. Additionally, Finnish maritime cluster is advancing environmental sustainability by investing in green technologies, designing energy-efficient vessels, and retrofitting ships with low-emission solutions, which reduces reliance on imported fossil fuels and strengthens energy security.

Maritime know-how is a critical factor in resilience, and many countries are increasing investments in this sector. European maritime industry plays a significant role in ensuring Europe's economic and strategic security, supporting both internal and external trade. Loss of shipbuilding capacity would undermine Europe's economic security and defense. Finland, along with Europe, must maintain and invest in maritime expertise and infrastructure to ensure a well-functioning industry.

The maritime sector's resilience is also dependent on a robust supply chain for critical assets. Domestic production of advanced maritime equipment and investment in shipbuilding capacity are necessary to maintain national and regional resilience. The ongoing global crises, such as the war in Ukraine, emphasize the need to secure supply chains and critical infrastructure. Finnish shipyards and marine manufacturers are vital in sustaining the production and maintenance of essential vessels, while digital tools enhance operational resilience through remote monitoring.

In conclusion, Finland's maritime technology industry is a cornerstone of national resilience. By providing essential ships, systems, and expertise, the sector supports Finland's security of supply, economic stability, environmental sustainability, and national defense. As global challenges evolve, Finland's maritime technology industry will remain crucial in securing the nation's resilience and its role in regional and global stability.

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Safety and securing in maritime logistics

Expert article • 3761

The security situation in maritime logistics has changed. There are several explanatory factors, such as climate change and geopolitics, that are changing the operating environment. The importance of cybersecurity has increased. The phenomena are global and manifest in different ways in different sea regions. A single operator in maritime logistics has little chance of influencing them, but by taking different risks into account, as well as by anticipating and reacting, maritime logistics can be made safer and more secure.

Undisturbed transport chains are of paramount importance for the development of the world and national economy, as well as for economic development and various operators. Maritime logistics also play an important role in ensuring security of emergency supply in various crisis and disruption situations. When looking at the safety, security and cargo securing in maritime logistics, attention must be paid to occupational safety, the environmental impact of operations and adequate protection and cargo securing of the products being transported.

Safety at work in maritime logistics

In maritime logistics the accuracy of cargo information is of great importance also for occupational safety. Incorrect and incomplete cargo information and misdeclared dangerous cargo can cause dangerous situations when the ship is at sea, with limited available rescue operations. Particularly dangerous are the various fire situations onboard.

Occupational safety includes awareness and prevention of risky situations, maintenance of safe working environment and up-to-date skills. For example, an occupational safety risk in seaports and logistics operations is fumigants used in goods transported in containers and different dangerous situations when opening containers. Inadequate advance planning can jeopardise occupational safety.

In seaports, where employees represent different organisations, a common occupational safety culture is of great importance. By sharing information and increasing awareness of occupational safety risks and with occupational safety guidelines, it is possible to make maritime logistics safer.

Environmental impacts of maritime logistics

To slow down climate change, it must be possible to reduce emissions from maritime logistics and various adverse effects. With adequate loading plans it is possible to make the use of transport capacity and resources more effective. The aim is to make maritime transportation more efficient and less energy-consuming. New low-emission fuels are also being developed. New green fuels and the energy used in their production must also be sustainably and responsibly produced. With appropriate packing and sufficient cargo securing and lashing, products can be transported undamaged and there is no need to be re-produce or retransportation. Also, no waste and wastage will be caused. Together, all these can reduce environmental burden and negative environmental impacts. To achieve these goals continuous development, research and further education is needed.

Seaworthy packing and cargo securing in maritime logistics

Usually, the transport chain includes several types of transportation. The packing and cargo securing must be planned and made according to the most demanding transport mode during the transport chain from the beginning to the end. Particularly the stresses during maritime transport differ greatly from the challenges of other modes of transport. For this reason, the packing and cargo securing must plan and do for maritime transportation, even if the cargo transport unit is transported partially by another transport mode. Most cargo damage could be prevented with the right planning. It is important that the goods are delivered to the recipient in good condition, in the agreed schedule and that the transport equipment is not damaged.

A seaworthy package is a package that provides sufficient protection against the mechanical and climatic stresses of maritime transport. The purpose of the package is to protect the product from the environment and the environment from the product, to facilitate the handling of the product, to enable and withstand cargo securing and lashing during transport, and to provide adequate information about the product. Inadequate and incorrect planning, packing, cargo securing and lashing may cause hazards to people, goods and the environment during the transport chain. It has been said that an inappropriate and broken package is the most unecological one.

The purpose of the packing and cargo securing is to reduce cargo damage, improve transport safety, increase risk management and reduce environmental damage. Cargo damage causes always also indirect costs and harm, and all damage is not compensable or measurable with money. Therefore, the proper packing, sufficient protection, right cargo securing and required information about the product is crucially important.

In Finland, the Cargo Securing Working Group works together across borders to promote cargo securing and to make logistics safe, taking into consideration different modes and actors of transport.

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MARKKU MÄKIPERE

Finland is an island – luckily

Expert article • 3762

As one of Europe's northernmost countries, Finland's location is often perceived as disadvantageous, as all our main markets are overseas, which means that logistics costs are expensive. Today, approximately 96% of Finland's export and import volume is transported by sea. Only a very small part of our foreign trade volumes is transported via a fixed land connection to Sweden or by air freight. Our location is often compared to an island, because in terms of exports and imports, our logistic is very similar to those of island countries.

An overseas or insular location is generally not considered a strength, although in a sense there are significantly more accessible "neighbouring" countries than land without a coastline. I want to shake up traditional perspectives and bring forward ideas where our location beyond the Baltic Sea could be seen as a competitive advantage and enabler.

Finland has a long coastline. Its impact is significant, among other things, on the location of industries on the coast. The most important regions for Finnish exports are the coastal areas. These areas have the best opportunities to utilise shipping for business purposes. Ship connections and ports not only enable exports, but also the import of raw materials, fuels and components needed by industries.

Although a logistical location closer to the main markets and by seas that remain unfrozen all year round would be more cost-effective in many ways, we also have our strengths. We are one of the richest countries in the EU area in terms of raw materials, and the large and sparsely populated country also enables several alternative, fossil-free energy production opportunities, which makes electricity in Finland the second cheapest in Europe and makes it easier to establish industrial projects than in densely populated countries.

Without the sea connection, Finland's situation would be considerably worse and more backward than it is now. We would be landlocked like Austria, Switzerland or the Czech Republic, but further away from the market. Besides we have a smaller population, greater distances and more challenging natural conditions. The competitiveness of our industry would hardly be at its current level and our price level would be significantly more expensive than at present. Landlocked countries are always dependent on ports and other infrastructure on the territory of third countries and their capacities. It certainly does not improve the country's competitiveness and the investments in the country.

Thanks to well-functioning maritime logistics and a comprehensive port network, we are better able to meet climate targets and cost-competitiveness. Maritime transport is the most cost-effective and environmentally friendly long-distance mode of transport per tonne transported. The total volume of Finnish maritime traffic corresponds to the capacity of approximately six million transport units. If all these were transported by road or rail through a third country, there would undoubtedly be emissions and costs at a completely different level than they are at present. Dependence on shipping and our numerous ports have created very high-quality expertise in marine industry and cargo handling technology in Finland.

The challenge for maritime transport is slowness, but it can also be seen as an advantage. Finland's security of supply with regard to critical raw materials and fuels is at a good level, as the relative slowness of ship traffic and larger batch sizes force us to maintain higher stock levels. In an uncertain situation, nearby and sufficient stocks are only a positive thing. At present, the importance of the sea and the coast for border security cannot be underestimated either. Maritime surveillance is more effective than a land border of similar length. From a defensive point of view, the long coastline can be seen as a deterrence, as the coast allows more response time than the land border.

The role of logistics, shipping and port operations must be understood correctly in Finland. Finnish ports do not act as transit hubs like the large ports in Central Europe, but they serve Finnish industry and society in particular. Their activities must be based solely and exclusively on the domestic needs. The role of Finnish ports is not understood correctly in decision-making, as they are almost all owned by municipalities. A single municipality or city is not the right unit to decide and make optimal overall decisions that make the best use of maritime opportunities.

Although the openness and free movement of the Baltic Sea in the event of a crisis is currently one of the main concerns, maritime transport must nevertheless be regarded as the safest mode of transport. However, we must prepare for the worst and make contingency plans for it if the sea connection does not always work. Finland's fixed land connections must be developed in order to reduce dependence on a single mode of transport.

Finland is like an island and thus dependent on shipping. The opportunities it creates must be realized and weaknesses transformed into strengths and competitive advantages that must be enhanced and supported.

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Container shipping's moment of fame and the quest for resilience

Expert article • 3763

Since the box's invention in late 1950s, container shipping has been one of the largest segments in maritime transportation. Despite this significant role and the large tangible components such as the army of colorful containers, large ports, huge gantry cranes, ever growing ships the industry remained rather invisible until lately. Well known by the sector's large companies, international governing bodies and vast labor force, it is even sealed with a prejudice of being 'conservative' in lightest terms, referring to resistance to change. However, the Covid-19 pandemic and its aftermath changed this picture fundamentally.

Empty shelves at supermarkets, consumer hoarding of essential supplies, unreliable delivery times of online orders and the soaring prices attracted the attention to shipping which have been treated as an endless pipeline that moves goods around the world as if they are liquids that flow without friction for a long time. Container shipping, since then, is cited together with border closures, canal blockage, geopolitical crises, tariffs, broken bridges, port strikes, low water levels, hurricanes, piracy and armed attacks. These are not new to centuries-old maritime transportation, but the increased frequency and the intertwined nature is affecting the industry far more than ever.

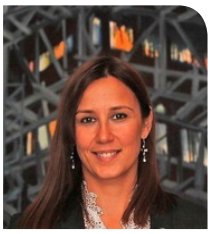
Resilience has become crucial for container shipping in these turbulent times. The segment was relatively better off with respect to available supply capacity in early 2020. Expecting the global merchandise trade to drop radically, liners reduced capacity as much as they can through scrapping, selling or speeding up off-hires. However, the quick recovery in global demand after the second half of 2020 coupled with the reduced capacity resulted in increased rates, lack of space and lack of containers. The blockages in inland transportation exacerbated the situation with empty containers and port congestions. The blockage of Suez Canal by a vessel in March 2021 drove container freight rates to record high levels. The global container freight index was showing $10,377 /40ft container by September 2021 in comparison to the $1,420 average in 2019.

Although these rates settled down as new vessel capacity came in throughout 2022 and 2023, the disruptions did not end. The year 2022 was marked with the invasion of Ukraine by Russia and the draught in Europe. In 2023, it was the low water levels at Panama Canal causing container vessels to take longer routes this time. Late 2023 and the whole 2024 was marked with Israel-Palestine war which resulted in container lines to reroute around Cape of Good Hope due to the Houthi attacks to ships passing through Suez. These disruptions evened out the excess shipping capacity and the hopes for rate reductions as well as reliability improvements in shipping services. Since 2020, the reliability of container shipping services, which is the main value proposition of liner shipping, has diminished significantly to 50% levels.

New shipping capacity will be introduced in 2025 and 2026, yet at a lower rate. Although this is promising for a reduction in freight rates, uncertainties around geopolitics, Trump's tariff plans and climate crisis keep resilience high on the agenda for container shipping. There are different strategies to pursue:

- Build flexibility through rapid operational transformations such as changing service providers, port calls, transport modes, container type or alliances: This is particularly relevant during capacity shortages but also a measure to tackle with the changing trade patterns. During and after the pandemic, friendshoring and supply chain regionalization became buzzwords. They will become even more important with the tariff wars and trade restrictions. Although supply chains are actually not becoming local or shorter, trade started to operate in horizontal and vertical silos to avoid the disturbances in transport networks which means bringing the nearest tiers of suppliers nearby but letting the upper streams of suppliers offshore. The recently introduced hub and spoke system from Gemini Alliance is an example for a flexible liner system with high reliability as the value proposition.
- Build redundancy and diversify: This strategy manifested itself in expanding capacity with new ship orders, new container fleets and new port agreements. Furthermore, container lines are now diversifying their service portfolio with road transportation, rail services, distribution centers, air transportation, customs services and even e-commerce to provide logistics and door-to-door services. Vertical integration in the transport chain is seen as a control strategy.
- Build strategic and multilateral relationships with other actors: During the times of crises, the winners are not those with the largest asset base or financial resources, it is those that have better access to alternative services, rates, routes and accurate and reliable information. These strategies manifest in the form of long-term shipping contracts and joint digitalization investments for continuous information flow between shippers and shipping lines.

The future will not be short of disruptions with the climate crisis being the biggest one. Shipping will need to adapt decarbonization measures to reduce its impact on climate and build resilience to tackle with the impact of climate crisis on shipping infrastructure. Coupled with the trade wars and geopolitical unrest, those players that implement effective resilience strategies will be ahead of competition in container shipping markets of the future.



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Oil spill risk in the Baltic Sea

Expert article • 3764

The Baltic Sea is a vital maritime hub that connects Northern and Eastern Europe, surrounded by nine countries—Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. Known for its brackish waters and fragile ecosystems, this semi-enclosed sea is both ecologically unique and commercially indispensable. However, it faces growing risks of oil spills due to several intertwined factors: expanding tanker traffic, aging vessels, geopolitical tensions, and challenging navigational conditions. These issues threaten not only marine life but also the economic well-being of coastal communities and the broader European trade network.

Shipping traffic in the Baltic Sea has increased substantially over the years. Busy shipping lanes heighten the risk of collisions, groundings, or other accidents, especially under extreme weather conditions such as fog, ice, or storms. Even small errors in a narrow and crowded maritime corridor can trigger serious incidents leading to oil spills. When oil tankers are involved, a single error can result in release of large volumes of oil, leaving severe environmental and economic consequences.

The Baltic's geography adds to its vulnerability. With narrow straits, shallow waters, and limited water exchange with the North Sea, the region is less capable of diluting pollutants compared to open oceans. This means that any spill can persist longer and exacerbate ecological damage. The sea's brackish water supports species adapted to an environment neither purely fresh nor fully saline, which makes them particularly sensitive to chemical contamination. Oil on the surface coats seabirds' feathers, stripping them of insulation and buoyancy. Many die from hypothermia or drowning. Beneath the surface, oil can kill fish eggs and larvae, disrupt reproductive cycles, and poison entire food webs. Benthic communities on the seafloor may be smothered if oil settles there, and because the Baltic's waters replenish slowly, the ecosystem may take years to recover from a serious spill.

The economic toll of a large oil spill would be equally devastating. Many coastal communities in the region depend on tourism and fishing, industries that are highly vulnerable to pollution. Oil-covered beaches and dying marine life not only discourage visitors but also disrupt local fisheries if fish stocks are contaminated or breeding grounds destroyed. Beyond regional impacts, the Baltic Sea is a critical transport corridor for European trade. A major spill could block shipping lanes, causing supply chain bottlenecks for essential goods and raw materials. Cleanup and recovery efforts might cost millions or even billions of euros, straining government budgets. Legal disputes over liability and compensation could further inflame tensions among Baltic states and shipping companies.

One emerging concern that heightens this risk is the prevalence of older or poorly maintained tankers, particularly in the context of geopolitical tension. It is reported that some "shadow fleet" of vessels are operating in the region under flags of convenience or obscuring true ownership, allowing them to bypass stricter regulations. Many of these ships may be near the limit of their operational life and thus prone to mechanical failures or hull breaches. Meanwhile, regional authorities have become more vigilant. Ship-to-ship transfers in offshore areas and potential sabotage of maritime infrastructure seem to be more pressing issues as geopolitical dynamics shift. Additionally, ice poses extra hazards: older vessels can suffer structural damage in cold, icy waters, and a hull rupture under such conditions could release huge amounts of oil. Ice itself complicates emergency response efforts, making containment and cleanup even more challenging.

Reducing oil spill risks in the Baltic Sea requires both preventative measures and effective response strategies. Phasing out older tankers and enforcing strict inspections, especially for those operating under flags of convenience, are key to identifying high-risk ships. Upgrading navigational systems and providing continuous crew training can help avoid collisions in the region's crowded, narrow lanes. Monitoring suspicious vessel movements also becomes essential given ongoing geopolitical tensions that may push some operators toward risky or clandestine practices.

When a spill does occur, rapid detection and mobilization are crucial. Authorities employ satellite imagery, aerial surveillance, and shared data networks to pinpoint slicks before they spread widely. Equipment such as booms and skimmers is stored in strategic locations for quick deployment. Regular multinational drills foster cooperation among coast guards, navies, and environmental agencies, ensuring everyone understands their roles in a joint response. Baltic Sea nations coordinate through frameworks like the Helsinki Commission (HELCOM), which sets pollution-prevention guidelines, organizes training exercises, and promotes the sharing of technologies and resources such as oil recovery vessels and chemical dispersants.

Once a spill is contained, cleanup focuses on restoring vulnerable habitats and monitoring conditions in the water and on the seafloor. This process often involves local stakeholders, including fishers, tourism operators, and environmental NGOs, who help ensure recovery strategies align with community needs. Research cooperation among countries and scientific institutions are also critical in refining methods to prevent accidental spills and improve cleanup efforts.

Ultimately, reducing oil spill risk in the Baltic Sea demands a united front. Modernizing fleets, enforcing regulations, refining rapid-response capabilities, and prioritizing ecological restoration are all part of a coordinated approach to protect this critical waterway. Robust regulation, continuous innovation, and proactive collaboration can help prevent disasters and mitigate their effects, preserving the unique marine environment and sustaining the region's economies. While it is impossible to eliminate every risk, steadfast commitment can keep the Baltic Sea on track for a safer, more sustainable future.

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Tackling chemical tanker pollution

Expert article • 3765

The Baltic Sea is one of the busiest seas in the world: about 2,000 cargo ships sail the Baltic Sea every moment. Among these, chemical tankers play an important role in transporting raw materials and products for the chemical industry across the sea, but it comes with significant environmental challenges, specifically related to pollution. The Baltic Sea is particularly vulnerable to pollution because of its brackish and shallow water and limited water exchange, which makes harmful substances persist longer in the ecosystem. According to the latest HELCOM HOLAS report handling the ecosystem health of the Baltic Sea, hazardous substances have been identified as the second biggest threat to the sea's health alongside eutrophication. One identified source of these hazardous substances is the maritime transport of liquid bulk cargoes – that is, chemicals.

When a chemical tanker washes its tanks, hundreds of litres of harmful and hazardous chemicals can end up in the marine ecosystem in one go along with the washing water. After unloading their cargo, chemical tankers often wash their tanks with seawater en route to the next port of loading. International regulations permit the discharge of tank washing waters into the sea under certain conditions. When a ship discharges its washing waters, it must be sailing at least 12 nautical miles (about 22 kilometres) from the nearest coastline in areas of at least 25 metres in depth. In practice, this leads to discharges being concentrated in specific sea areas, such as the heavily trafficked but shallow Gulf of Finland. Current regulations restrict the discharge of tank washing waters into the sea only for the most hazardous substances. However, the release of harmful chemicals, such as carcinogenic benzene; styrene, which is toxic to aquatic organisms; and phenol, which has been shown to have a major impact on the growth of algae and other organisms even in very low concentrations, is still allowed.

The chemical industry's voluntary initiatives have shown promise in reducing these emissions. In John Nurminen Foundation's Chemical Tanker Project, done in cooperation with the Finnish Transport and Communications Agency Traficom, Coalition Clean Baltic, and the Swedish Transport Agency Transportstyrelsen, we have sought practical solutions together with the Finnish chemical industry and ports to minimize the chemical emissions. For example, for tall oil and styrene, there are already cost-effective ways to treat tank washing waters on land so that cargo residues are reused and do not end up in the sea. In 2023, all Finnish tall oil operators committed to ending tank washing discharges into the Baltic Sea. Some companies had already developed methods for handling washing waters onshore, and best practices were shared across the industry. These efforts demonstrate that voluntary actions can reduce environmental impacts while enhancing corporate responsibility and industry image.

Despite these efforts, obstacles still exist. International maritime regulations are often less stringent than national laws, allowing certain emissions at sea that would be prohibited on land. Monitoring activities on international waters is challenging, and vessels responsible for illegal discharges are rarely held accountable. The cumulative impact of various chemical discharges, "chemical cocktails", on the sea and its organisms is not yet fully understood. At the moment, there is insufficient data on the types and quantities of harmful substances entering the sea from vessels, making maritime traffic a blind spot in environmental monitoring. But one thing is sure: different chemicals are being discharged into the Baltic Sea daily. To tackle the problem entirely, stricter international regulations are essential. These must include prohibiting tank washing water discharges, strengthening monitoring systems, and ensuring compliance through more effective enforcement.

To address these issues, the John Nurminen Foundation encourages the chemical industry to adopt a broader perspective that extends beyond factory emissions to encompass the entire transportation chain. Responsible companies should ensure that the ships and terminals they utilize do not contribute to the discharges of harmful substances into the sea. Taking proactive measures today by exceeding the legal minimum requirements not only benefits the Baltic Sea but also prepares the industry for the likely regulatory changes happening in the near future.

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The shadow fleet heightens the environmental risks in the Baltic Sea

Expert article • 3766

The environmental risks associated with maritime traffic in the Baltic Sea have long been recognized, and the current geopolitical situation has only intensified these concerns. The Baltic Sea is one of the world's busiest sea areas, with the primary concern being cargo ships transporting liquid products such as crude oil, oil products, and chemicals from Russia. Additionally, since all large ships carry substantial amounts of fuel, any shipping accident carries the risk of an oil spill.

The ongoing Russian war in Ukraine and the subsequent sanctions imposed by Western countries have led to a shift in trade patterns. European nations have reduced their reliance on Russian oil while countries in Asia and Africa have emerged as new trading partners for Russia. This shift has resulted in a transition from legally registered commercial tankers to a shadow fleet with unclear ownership and frequently changing flag states.

This fleet poses a significant hazard to the Baltic marine environment, as evidenced by numerous incidents that have occurred globally including, for example, in the Danish Straits. The shadow tankers are often outdated, in poor condition, and prone to technical defects, with inadequate insurance coverage. Many of these vessels operate without the double hulls required by international regulations and may also neglect ballast water management which is essential for preventing the spread of invasive aquatic species and harmful pathogens. It is known that some shadow tankers have falsified their location data or deactivated their AIS systems to conceal their operations in Russia. Additionally, these vessels have been linked to the sabotage of underwater infrastructure, potentially damaging the seabed. It is also suggested that these tankers have previously conducted hazardous ship-to-ship cargo transfers at sea. Moreover, Russia's interference with the navigation system (GNSS) to protect its oil terminals and refineries from drone attacks has led to ships deviating from their courses, putting them at risk of running aground. This disturbance is believed to have led to four near-miss incidents in the Gulf of Finland during autumn 2024.

Risks of navigation

The Baltic Sea presents a particularly challenging environment for navigation. The sea is shallow with narrow waterways, and its archipelagos require ships to navigate around rocks and skerries, increasing the risk of groundings. The waterways intersect east-west and north-south, raising the likelihood of collisions. During the winter and autumn months, ice conditions and limited daylight hours make navigation even more perilous, particularly for crews unfamiliar with the region's conditions. A lack of safety culture onboard exacerbates these risks.

Environmental impacts of accidents

The Baltic Sea is a unique ecosystem characterized by brackish water, shallow depths, limited water exchange, and diverse habitats that support a variety of distinctive marine and freshwater species, including endemic ones. It is home to several threatened species and serves as an important migratory area for arctic birds. These characteristics make the Baltic Sea ecosystem particularly sensitive to environmental disturbances, and highly vulnerable to the effects of oil and other harmful substances, which can accumulate in the food web. The slow circulation of water allows pollutants to persist for extended periods, which further amplifies their impact.

Assessing the environmental impacts of maritime accidents is challenging, yet essential for effective recovery planning. The consequences depend on factors such as the location, season, and timing of the accident as well as the properties and behavior of the substance leaking into the sea. Interactions between harmful substances and the ecosystem are complex, and real-time tracking of spills can be difficult. The long-term and cumulative effects may only become apparent over time. While the effects of oil spills are somewhat understood, chemical pollutants encompass a wide range of substances, each with unique behaviors that may be even more difficult to manage and recover than oil. Tankers can carry multiple types of chemicals simultaneously, meaning an accident could involve a mixture of substances spilling into the sea.

Certain areas, habitats, and species are more vulnerable to contamination than others. For example, seashore meadows and sandy beaches are considered the highest-risk areas for oil spills due to their slow and uncertain recovery, and the difficulty of cleaning them. The most severe acute impacts of an oil spill are typically experienced by seabirds, whose mortality rates are highest and recovery often the most challenging. In addition to birds, some crustaceans, aquatic plants, and littoral fish, as well as seals are among the most sensitive species to the long-term impacts of oil.

Managing risks

The outdated tanker fleet, along with other unforeseen hazards arising from the current geopolitical tensions, has heightened the need to strengthen risk management and preparedness for adverse events. Sharing information among states and authorities to understand both safety and security risks, and agreeing on measures to control or restrict the use of the shadow fleet is crucial for preventing accidents.

The Baltic Sea countries have a robust system of national and regional cooperation for responding to oil and chemical accidents, with established protocols, joint response mechanisms, and regular training exercises. However, response actions vary depending on the substance involved and the specific conditions, making each case unique.

Science plays a key role in advancing the understanding and management of risks. Two new research projects – CoWup[1] and WATERWAYS[2] – focusing on marine and maritime risks in the Baltic Sea began in January 2025, funded by the Strategic Research Council of Finland. Involving a wide range of expert stakeholders, these projects aim to identify and analyze environmental, operational, security, and geopolitical risks, with the goal of enhancing society's ability to monitor, prepare for, and respond to undesirable events.

1 *Coastal waters under pressure – safeguarding a healthy Gulf of Finland in a changing geopolitical and environmental landscape.*

2 *Marine waterways as a sustainable source of wellbeing, security, and safety.*

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The shipping industry meets the challenge of climate neutrality

Expert article • 3767

The main challenge for the maritime transport and related logistics industry in the coming years is undoubtedly the energy transition process. It is estimated that about 90% of international freight traffic uses maritime transport and that it contributes a few percentage points to the CO2 produced globally, from 2 to 4% depending on the source; nevertheless the choice of multilateral bodies in charge of regulating the sector, the IMO *in primis*, has been to aim for carbon neutrality by 2050, a horizon that appears rather close in time if one considers the average lifetime of a ship. At the regional level, the European Union in order to facilitate this transition process is funding some research projects (e.g. PIONEERS. MAGPIE, PERMAGOV, etc.) and has approved two instruments: the application of the Emission Trading Scheme (ETS) to maritime transport by extending the scope of the EU ETS (Directive 2003/87/EC) and the adoption of the FuelEU Maritime Regulation (Regulation (EU) 2023/1805) aimed at promoting the use of renewable, low-carbon fuels and clean energy technologies for ships.

Both provisions apply to ships calling at a European port and for this reason they have not been exempt from criticism by shipping companies operating on routes and markets that may be subject to competition from neighbouring ports but belonging to non-EU countries and therefore not subject to these requirements. This does not, however, seem to be the case for those operating in the Baltic Sea as all the countries facing it are members of the European Union with the sole exception of Russia, towards which strong trade sanctions have been imposed limiting its role in the geography of maritime cargo traffic, at least in the current scenario.

Achieving carbon neutrality in the shipping industry will require work on several fronts, as no truly green solutions - in a weel-to-wheels logic, i.e. including energy production and use phases - are yet ready, or at least not to the extent necessary to reduce the global shipping industry's CO2 production to zero.

Therefore, while maintaining the ultimate goal of carbon neutrality, it is necessary to define a pathway - it is no coincidence that this is referred to as a transition process - for its attainment with a significant reduction in emissions as the first objective. Approaches include the search for lower emissions through the use of new fuels (from LNG, which is already widespread in shipping, to biofuels, methanol, ammonia, etc.), batteries, rotors, sails, and the use of shore power systems while in port, as well as the search for lower fuel consumption through hydrodynamic solutions and innovations in propulsion systems that can ensure greater efficiency of ships. In addition, there are technologies for the recovery and treatment of the emissions produced, such as the widespread use of scrubbers and other solutions for carbon capture and storage; solutions that are also suitable for ships already in service in order to avoid excessively onerous retrofitting costs.

This concise and by no means exhaustive list shows how the sector is faced with a variety of possible solutions that makes the choice of the technological solution to invest in particularly complex and risks creating a 'surplace' situation that delays the necessary investments. In fact, it depends both on elements internal to the shipping company – as the type of ships used, the characteristics of the routes on which the ship is expected to operate - and on external elements involving the other players in the supply chain, from ports to terminal operators to the land-based logistics. This is a situation that is neither new nor uncommon in network industries and that can be addressed by working at the supply chain level, thus in the case of shipping through the creation of corridors around the sharing of a particular technological solution. This may be the case, for example, with corridors developed around the use of batteries that will involve not only investment in battery-powered ships but also the provision in the ports called by such ships of equipment that will allow batteries to be recharged or replaced (e.g. through the use of container battery storage), as well as dedicated battery yard spaces and battery maintenance services. This is similar to what is being done with regard to the corridors for the use of green hydrogen and its derivatives, methanol and ammonia, as fuels for ships. This way of proceeding may provide useful insights into the scalability of the technological solutions pioneered by each corridor, but it does not eliminate the risk for operators of investing in technologies that may fail to take off in the market or that may be overtaken by other technological solutions. To try to overcome this risk, it is necessary to involve regional or global stakeholders who should have an interest in not investing in a wide range of different technological solutions, but rather in replicating the choices already made on new corridors and new routes in order to exploit some kind of scale or scope economies.

Lastly, it should be borne in mind that the energy transition process is partially changing the role of ports which will tend to become nodes where energy production, storage and distribution are concentrated and that this process sees maritime transport as the first and main counterpart but in some ports the volumes of energy produced may well exceed the needs of maritime transport alone, thus being able to be offered to land-based logistics operators as well as to other industries of households settled in port regions. It is therefore possible that decisions on the technological solution to be invested in could be concerted by the shipping industry together with the regions forming the hinterland and foreland of the ports connected by a sea route, thus helping to reach the dimensional thresholds of demand that would justify the investments in energy production, storage and distribution while reducing the risk associated with the technological solution chosen.

While the goal of shipping's carbon neutrality is now clearly identified and is shared by all players in the shipping industry, the road to achieving it seems still long and not without its pitfalls, but thanks to the cooperation of all players involved, including the new players in the energy and IT sectors, this goal can be achieved.

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2025: a critical year for shipping decarbonization

Expert article • 3768

The "Revised 2023 IMO Strategy" was adopted in the 80th session of the Marine Environment Protection Committee (MEPC 80) of the International Maritime Organization (IMO) in July 2023 and supersedes the "Initial IMO Strategy" that was adopted at MEPC 72 in April 2018. It has set, among other things, even more ambitious targets to reduce greenhouse gas (GHG) emissions from ships The main targets include reaching net-zero GHG emissions by or around 2050, and GHG emissions reductions of at least 20% (strive for 30%) by 2030, and 70% (strive for 80%) by 2040, all vs 2008 levels.

The "Initial IMO Strategy" that was adopted at MEPC 72 in April 2018 had as main targets to reduce GHG emissions by 2050 at least 50% vis-à-vis 2008 levels, and to reduce CO2 emissions per transport work ("carbon intensity") by 2030 at least 40%, again vis-à-vis 2008 levels. The latter target is retained in the Revised Strategy, but the 50% GHG reduction target is now obsolete, being superseded by the net zero by or around 2050 target and the new 2030 and 2040 GHG reduction targets.

Still, and even though a slight decrease of carbon intensity has been observed in some shipping sectors, the absolute levels of CO2 (and therefore GHG) emissions exhibit a clear positive trend, with no sign of a peak, let alone a drastic reduction.

Critical in the ability of shipping to decarbonize are Market Based Measures (MBMs), also known as economic measures. These aim at applying the "polluter pays" principle and at internalizing the external costs of GHG emissions. MBMs would induce changes in ship owner behavior that would reduce GHG emissions. In the short run, they could induce slow steaming or other logistics-based measures that would lead to reduced GHG emissions. In the long run, they could incentivize the adoption of energy savings technologies or alternative, low or zero carbon fuels that are not economically viable so long as the price of fossil fuels remains low.

In 2010 the IMO evaluated as many as eleven separate MBMs, submitted by various member states and other organizations. However, the IMO suspended the MBM discussion in 2013, as a result of highly divergent views across IMO member states on the subject of GHG emissions.

In 2018, MBMs were included in the Initial IMO Strategy as a candidate *mid-term* measure, to be finalized and agreed to between 2023 and 2030. However, the real discussion on MBMs did not restart until 2022, mainly due to the prioritization of *short-term* measures, that were to be agreed to until 2023. Short-term measures include rules mostly relevant for the 2030 carbon intensity 40% reduction target.

In parallel, the inclusion of shipping into the EU Emissions Trading System (ETS) in the context of the European Green Deal was achieved by an EU Directive in 2023. A phased application is envisaged, starting in 2024 and with full application from 2026 on. Also from 2026 on, GHGs other than CO2 will count.

At this point in time the IMO is discussing a "basket" of mid-term measures. Whereas some (but not full) convergence has been observed on the technical element of the basket, which is essentially a Green Fuel Standard, little or no convergence exists on the economic element (or MBM). ETS has been ruled out as a possible global MBM, and the discussion focuses on a possible carbon levy.

Proponents of a carbon levy include Pacific island states (Marshall Islands, Solomon Islands, and others), the EU-27+the European Commission, Japan, Canada, and some shipping associations. However, there is no full alignment among all these proponents, and their views on the subject are fragmented.

Strongly against a levy are China, India, Saudi Arabia, South Africa, Brazil, Argentina, and other developing countries. Their view is that a carbon levy will ruin their economies. They went as far as strongly rejecting the economic part of the Comprehensive Impact Assessment (CIA) study commissioned by the IMO on the mid-term measures.

Russia, Norway, and the US complement these countries. Norway was for a global ETS but later joined China et al. in their proposal, which only includes a Green Fuel Standard. Even though the US under President Biden endorsed the Revised Strategy in 2023, the re-election of Donald Trump is a development that can not be ignored. Since the US, even under the Biden administration, did not endorse an economic measure, it is hard to see how it will do so under a second Trump administration. But of course this remains to be seen.

How (or if) this serious lack of convergence will be resolved is not clear. The IMO has to decide on a mid-term measure by 2025, and whatever measure is adopted will be implemented by 2027. Several IMO meetings are scheduled for 2025 on this subject, including an extraordinary MEPC session in addition to MEPC 83 (April 2025).

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Baltic Shipping Vision: innovative and green

Expert article • 3769

Introduction

Is it conceivable that large cargo and cruise ships will sail silently and emission-free through the Baltic Sea, powered by innovative sail systems, large batteries, hydrogen fuel cells and electric drives? Could the Baltic Sea become the world's first green shipping corridor? Can business, tourism and nature conservation go hand in hand, as proposed by the EU's Green Deal? Realistic opportunities or wishful thinking?

Shipping must contribute its fair share to global climate policy. The International Maritime Organisation (IMO) has set a global climate target for shipping of net zero emissions by 2050. Maritime transport is considered to be one of the most challenging tasks in the ongoing transformation process, as ships require large amounts of energy on long non-stop routes. Who will take the lead in this process? Isn't the Baltic Sea the perfect region to drive innovation and demonstrate the feasibility of a green shipping vision?

Status

The global status of the transition to low-carbon shipping paints a mixed picture. Looking at the emissions statistics, the tide has not turned significantly. However, the pace of innovation in propulsion technologies for ships is astonishing. In recent years, electric hybrid drives with powerful battery storage systems have been introduced. Combustion engines have been improved to use environmentally friendly fuels. Fuel cells are on their way to becoming part of zero-emission technologies. Perhaps the most visible innovation in shipbuilding is the rediscovery of wind propulsion. Large foldable wings and rotor sails have entered the market with a steep growth curve. Innovators from Europe are playing a central role in this, many of them based in the Baltic Sea region. However, the global market is only just developing and competitors, particularly from Asia, are catching up.

Success Factors

The transition to greener and more sustainable shipping is particularly successful when not only ship owners, but also cargo owners, their customers and the entire logistics chain drive the decisions for innovation and investment. Ship owners are open to a highly motivated transition when their customers demand green transport. This chain of demand can be extended to the end users of commercial goods. Cooperation in a market works even better on a smaller scale, where all stakeholders can take note of the achievements and benefit directly from innovation and sustainability, rather than in anonymous global markets pursuing primarily quick profits. This makes the Baltic Sea, and perhaps the whole of European waters, a favoured testing ground for the shipping of tomorrow.

Technological Drivers

There is also a technical side to all this. Innovation requires research as an essential prerequisite. Europe continues to excel in the scientific field of maritime technology, both in basic and application-orientated research. Cooperation between research and industry is well established and has great potential to bring innovative products to the market. New technologies must be developed step by step. Innovators need to gain experience with smaller units and systems before taking the next step and scaling up system sizes. The better the framework conditions for the innovation process, the greater the chances of success and rapid progress. Short sea shipping can be an important driver of technological change in ship propulsion. The required ranges of shipping services are much shorter than in far trades. System monitoring and the necessary services can be organised on short notice. This facilitates technical adjustments and fine-tuning of systems during the introduction phase, which is an important factor for the success of innovations in a market that demands highly reliable shipping services. The modern and comprehensive infrastructure of the Baltic Sea could play an important supporting role.

Conclusions

Technological and economic leadership results from several success factors. Many of these can be identified in the Baltic Sea region to support the development of green and sustainable shipping technologies. The maritime industry could be a key player in this developing market. High motivation and good cooperation between all stakeholders are crucial. Hesitation, disbelief or underestimating the power and pace of innovation can lead to falling behind and playing minor roles in new markets.

Europe is facing another opportunity to demonstrate its innovative potential. The Baltic Sea region can take the lead here. Ambitious shipping projects driven by the maritime industry and relevant stakeholders are on the horizon. Captains must go "Full Ahead" if this is necessary for a successful voyage.

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Risk assessment validity in the MASS Code

Expert article • 3770

Maritime Autonomous Surface Ships (MASS) continue to attract significant interest in industrial, regulatory, and academic environments. Aiming to revolutionize shipping by enabling maritime operations with reduced or minimal human intervention, these vessels rely on sensors, real-time communication, artificial intelligence, and automation, thereby enhancing efficiency, safety, and sustainability. Testbed applications at various degrees of autonomy have been piloted for several ship types, with commercial operations spearheaded in some markets. These include fully autonomous container ships in coastal navigation and remotely controlled inland vessels. Remote pilotage, where licensed pilots provide decision support for local navigation conditions from a remote location, has also received interest in several jurisdictions.

To enable safe, secure, and environmentally sound MASS operations, work is ongoing at the International Maritime Organization (IMO) to develop an International Code of Safety for Maritime Autonomous Surface Ships (MASS Code), which will supplement existing maritime regulations for aspects specific to MASS not covered under existing rules. It is designed as a goal-based instrument, in which high-level goals are formulated for a vessel, with Functional Requirements (FRs) and Expected Performance conditions (EPs) translating these goals into actionable benchmarks. These define what a MASS or its subsystems must achieve without prescribing specific methods or technologies, thus allowing flexibility and innovation.

In Goal-Based Standards, risk assessment is used to identify hazards, analyze and evaluate associated risks, and to support decisions on mitigating measures. Risk assessment can be used to identify and formulate FRs and EPs to operationalize the high-level goals of the generic MASS Code, and to ascertain that the technical design and operational procedures of a specific MASS meet these FRs and EPs. Various guidance documents exist for performing risk assessments in the maritime industry. For the MASS Code, IMO's guidelines for Formal Safety Assessment and the Risk Based Assessment Tool being developed under the auspices of the European Maritime Safety Agency are arguably the most important.

Based on the MASS Code draft version of September 2024 (MSC 109/5), and relying on recent findings in risk and safety research, two issues warranting more focus in developing this regulatory instrument are highlighted here.

First, whereas the draft Code refers to the need to use "suitable, recognized, and appropriate risk assessment techniques", there is little attention to the applicability of specific hazard and risk analysis methods for MASS systems. However, much academic work suggests that techniques such as Hazard and Operability (HAZOP) studies, Failure Mode and Effects Analysis (FMEA), and fault and event trees, all based on linear accident causation models, are ill-suited for assessing risk in complex sociotechnical systems. Considering for instance that MASS design and operation requires decision-making of many actors at various organizations and the importance of feedback mechanisms in the interconnected systems, which are essential tenets of accident causation in complex sociotechnical systems, techniques such as the Systems-Theoretic Process Analysis and the Event Analysis of Systemic Teamwork-Broken Links method are more suited for MASS risk assessment. These better align with systems views on accident causation, while research suggests that these identify more hazards than HAZOP and FMEA.

Second, the draft Code does not address quality requirements for MASS risk assessments, apart from tentatively noting that "risk assessment should be carried out by personnel with relevant expertise". Research however suggests that the comprehensiveness of hazard identification can vary significantly and that important differences in risk ratings may arise when analyses are executed by different teams and with different techniques. Hence, given the pivotal role of risk assessment in the MASS Code, there should be clearer guidance for personnel in industry and administrations on risk assessment quality to ensure that analyses are comprehensive, accurate, and credible. Guidance such as the Risk Analysis Quality Test by the Society for Risk Analysis, as well as validation frameworks tailored to specific hazard and risk analysis techniques proposed in the academic literature, can provide fruitful starting points for this work.

If risk assessment validity is insufficiently considered, there is a risk of false assurance about safety, i.e. a belief that the risks are appropriately assessed and mitigated, whereas this confidence in meeting the safety goals is unwarranted. While developing a MASS Code is a nuanced exercise requiring inputs from various experts, advocates of evidence-based policy making are urged to take note of the above, to ensure a robust and sustainable path towards vessel autonomy.

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Digital solutions in maritime logistics

Expert article • 3771

Maritime logistics: Embracing green transition and data sharing

Shipping has been a global business for thousands of years, evolving from ancient sailing vessels into today's modern, interconnected industry. At present, two key priorities dominate maritime logistics: 1) the green transition, which focuses on reducing CO_2 and other greenhouse gas emissions and increasing the use of renewable energy, and 2) the sharing and utilization of data. Enhanced information exchange among shipbrokers, shipping companies, ports, and authorities strengthens coordination, improves sustainability, and fosters both collaboration and innovation.

Toward digital tools

According to a report by the International Bank for Reconstruction and Development / International Development Association and The World Bank, there are various global initiatives driving the digitalization of maritime trade logistics. These include port call optimization and maritime single windows, cybersecurity solutions, health-related digital measures (*f.e.* Digital Health Security), port community systems, port management systems, and "Smartport" disruption strategies. Some of the digital initiatives are voluntary and business-driven, while others are mandatory and regulated.

Finland has been a leading developer of ship-to-shore digitalization, particularly in port call optimization and the maritime single window. Satakunta University of Applied Sciences (SAMK) has taken an active in these Finnish maritime digitalization efforts.

Port call optimization tool: Port Activity App

The Port Activity App (POLO Port Activity concept) is a mobile application providing real-time information on a vessel's port operations, from arrival to berth occupancy and departure. Its origins trace back to the 2016 European Maritime Days in Turku. The first version of the app was created through the Interreg Central Baltic-funded "Efficient Flow" project, using a Software as a Service (SaaS) concept, wherein the service provider manages all required resources.

After the Efficient Flow project ended in 2021, Fintraffic VTS assumed the role of SaaS provider, while Unikie Ltd. became the technical provider. In June 2024, the Port Activity App became part of Fintraffic's POLO service package. Over the years, functionalities of the app have expanded to include berth planning, invoicing, and other port services based on local needs. The app has received multiple national and international awards and has been successfully exported to other countries. POLO Port Activity exemplifies a business-driven, voluntary digital service in maritime logistics.

Sustainable process development of the Finnish Maritime Single Window (NEMO)

A Maritime Single Window (MSW) is a centralized platform for collecting and sharing information related to a vessel's port call, covering arrival, stay, and departure. As of 2024, the International Maritime Organization (IMO) requires all Member States to implement a MSW. In the European Union, a 2019 mandate established the European Maritime Single Window environment (EMSWe), compelling each member state to develop its own "Maritime National Single Window."

Finland's national system, known as the Finnish Maritime Single Window "NEMO," is currently under development and will be in use in 2026. SAMK's Maritime Logistics Research Center is participating in this process as part of the "NEMO CEF" project, funded by the European Commission's Connecting Europe Facility (22-FI-TG-NEMO-EMSW). The project is led by Fintraffic VTS, with the Finnish Transport and Communications Agency (Traficom) as an associated partner. SAMK oversees process development, stakeholders' expectations and skills development, Key Performance Indicator (KPI) design, and maritime pilot cases. A key theme in the NEMO CEF project is ensuring sustainability from the perspectives of planet, people, and profit.

The Future of maritime digitalization

Maritime digitalization has advanced rapidly over the past five years. Artificial intelligence (AI) is emerging in areas such as predicting vessels' virtual port arrivals and estimated times of arrival. Both voluntary (business-driven) and mandatory (regulatory) digital platforms in maritime logistics will increasingly integrate AI in the coming years, shaping a more efficient, sustainable, and data-driven industry.

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Challenges of the winter navigation system in the Baltic Sea

Expert article • 3772

The presence of sea ice significantly complicates shipping in the Northern part of the Baltic Sea. Moreover, the temporal and spatial variation of ice parameters makes it less predictable, hindering transportation reliability and sustainability.

Finland has more than 150 years' experience of winter navigation. Winter navigation principles are defined as part of the Finnish-Swedish Winter Navigation System (FSWNS), maintaining safe and efficient year-round navigation. The system consists of three elements: ice-strengthened ships, icebreaker assistance, and traffic restrictions. The traffic restrictions ensure that only ships with some minimum size and ice class will get icebreaker assistance on the winter period and the harder the ice conditions the stricter will be the traffic restrictions. This is to guarantee that the icebreaker fleet is capable of offering the service required with minimum waiting time for the merchant vessels. Specifically, to make sure that ships have enough ice-going capability for safe and efficient operations, they must be built and operated following the Finnish–Swedish Ice Class Rules.

Climate change will affect future ice conditions, so the maximum ice extent and average ice thickness is decreasing. At the same time, climate change can result in more stormy winds and waves, increasing ice movements. This makes the ice more dynamic, results in a higher possibility of forming ridged ice, and makes the ice conditions more spatially heterogeneous and less predictable. Furthermore, the active development of offshore wind farms in the Baltic Sea will affect the system behavior and operational ice conditions of ships. Moreover, offshore wind farms require assistance from specialized vessels, which produce additional non-typical ship traffic affecting the winter navigation system.

The size of a typical ship is growing in the future, and the new strict environmental regulations will decrease the engine power installed on ships. The International Maritime Organization (IMO) together with EU have adopted a number of new regulations to increase the energy efficiency of ships and to decrease dramatically the amount of greenhouse gases (GHGs) emitted by ships. Although their goal is to target GHG emissions, they also limit the maximum installed propulsion power of conventional oil-powered ships and favor open-water optimized hull forms due to their technical content. This will decrease the ice-going capabilities of these ships dramatically and can result in higher demand for icebreaker assistance.

Therefore, developing system-level simulation tools that study such factors is essential to understand and reliably predict future trends. Considering the importance of supporting the interannual maritime transportation of goods and passengers, we need decision-support tools to improve the performance of winter navigation and icebreaking assistance in the Baltic Sea. Such tools analyze the performance of winter navigation systems under potential operating scenarios, e.g., different ship traffic, icebreaking assistance, ice conditions, and regulations.

The results of the analysis can identify the bottlenecks of the winter navigation system regarding different key performance indicators (KPIs, e.g., the total waiting time, emissions, cost, and safety) and propose potential solutions contributing to efficient decision-making. Thus, the expertise of a decision-maker complemented by the capabilities of the winter navigation simulation tools may result in more efficient and sustainable maritime transport systems.

Over the last decades, a number of studies have contributed to the topic at hand by modeling the system-level performance of winter navigation. The latest development include a system level digital twin to simulate the system level performance of the winter navigation, developed by Aalto University together with Taltech, Estonian Maritime Academy. Specifically, novel algorithms have been developed to model the dynamics of the icebreaker resource availability, optimize icebreaker allocation, and study how changing the dirways affects FSWNS efficiency. Icebreaker scheduling involves determining the number of icebreakers available each day, their initial positions, and their designated operational areas. Additionally, mathematical modeling is employed at the ship level to capture individual vessel interactions with ice conditions and their impact on overall traffic flow. Vessel speeds under different ice conditions, such as convoys and towing, are calculated using closed-form expressions.

The tool can be used in future to predict the need for icebreakers and to plan their operation policies when ice conditions, maritime traffic, and characteristics of ice-strengthened ships will be under dynamic change and stricter environmental regulations will also affect both ice-breakers and ice-going ships.

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Arctic navigation risk mapping

Expert article • 3773

With the ice melting, maritime activity within the Arctic area has increased during the last 20 years. Most of this activity is related to the oil and gas industry, cruise vessels, supply of northern communities and fishing vessels. However, these activities are not equally distributed.

If global warming reduces the ice surface and thickness, this allows vessels to sail in previously deemed perilous areas. It also impacts the transit capacity of the Panama Canal. In recent years, one has observed the number of vessels transiting through the canal decreasing while the the transit time has considerably lengthened. Regarding the Suez Canal, the Houtti attacks have forced some maritime companies to sail via the Cape of Good Hope. Additionally, the March 2021 Ever Given case is still fresh in corporate minds notably as regards its economic impacts. Thus the question of safer and more reliable maritime routes is raised.

In this context, the Arctic Ocean increasingly appears as an alternative for some companies. As evidence, a joint venture between DP World and Rosatom for the management of containers along the Northern Sea Route (NSR) was signed in 2023. Nevertheless, sailing conditions and maritime activity slightly differ from one area to another. Repecting the announced schedules and related transit times is the main challenge of these new maritime lanes, which entails anticipating and mitigating risks.

High risk maritime routes

Currently, two passages are used: the North-West Passage (NWP) along the Canadian and American shores, and the North-East Passage (NEP) mainly represented by the waters of the Russian Exclusive Economic Zone (EEZ). The maritime activity in the NEP is made up of oil and gaz exportations, fishing, cruiseliners and ferries (in the Norwegian part), vital supplies of northern communities and the necessary deliveries to upgrade existing ports and terminals. The transit activity within this area is rising in volume, but remains limited compared to the amount of cargo exported.

The environment, the seafarers and the vessels are all at risk when sailing in this area, and it requires an appropriate risk management policy. Until now, maritime codes and conventions have been implemented in response to casualties, but the International Code for Ships Operating in Polar Waters i.e. the "Polar Code" (PC) entered into force in 2017 appears as a prophylactic instrument. Amending the SOLAS and MARPOL conventions, the PC provides tools to secure polar navigation. However, even if it recalls existing risks a vessel may face within Arctic, the PC only deals with those ships having more than 500 gross tonnage (GT), which is not at all representative of all the navigation throughout the area where small vessels operate.

A 20-year database covering 2000-2020 was to map the main causes of numerous accidents depending on the level of gravity, vessel type, area, and season. The analysis of that database has led to the following risk mapping in the Arctic.

Serious accidents caused by machinery, sandbanks and ice

First, whatever the type of vessel may be, *Marine Incident* (lowest level of gravity) represent 5.8% of the events assessed, the rest being *Serious* (82.1%) or *Very Serious Casualties* (12.2%), meaning that in most cases, the integrity of the vessel is called into question. Such a result clearly stresses that there are no small incidents in Arctic waters.

Looking at the main causes of accidents, machinery (32.2%) is the leading accident factor, wrecked (20%) the second, and climate (12%) the third. Machinery damage raises concerns on the level of ship's maintenance and the capability of coastal states to offer safe ports for refuge and repairs.

Wrecks are a consequence of the persistent difficulty in mapping the Arctic seabed and the need to identify the various sandbanks. This also explains the reason why underwriters ask shipowners to define the voyage planning they will follow and be assisted by an icebreaker.

Ice represents a double risk for navigation. Its presence can have an impact not only on vessels' ability to sail but also on the capability of other vessels to help a ship in danger. Moreover, ice has the potential to cause serious casualties or aggravate the consequences of an accident.

An aging fleet of vessels

Fishing vessels represent the highest share of casualties. As most of their GT is below 500 GT, they have no obligation to comply with the Polar Code and their average age is 28 years old, which raises the question of their renewal.

Because of the remoteness of the Russian oil and gas fields, the only way to replenish the plants is by sea, but tankers involved in accidents are 12 years older than the fleet average. However, with the construction of Sabetta and the Yamal LNG Plant, most hydrocarbons exported from Russian terminals are LNG, meaning that the fleet is quite new, and most vessels carrying gas are ARC-7 (able to sail up to ice which is 2.4 m thick).

Despite this, it is striking to notice that cargo ships involved in accidents are 10 years older than the fleet average, and passenger ships are 6.5 years older. Considering the growing regional traffic, the renewal of the latter is of paramount importance.

Search And Rescue (SAR) infrastructures

The density of SAR is unequally distributed between Norway and Russia. Surprisingly, no accidents were reported along the NSR between the Kara Gate and Bering Strait. This questions the data shared by costal states. Knowing that this location faces the largest oil and gas shipments, it constitutes a significant obstacle to analysis.

The area with the highest number of casualties is along the Norwegian shores and in the western part of the NEP, between the Kola Peninsula and the Novaya-Zemlya islands for the west part and within the Okhotsk Sea. SAR presence solves the issue of remoteness and the vessels' ability to receive assistance. SAR connection to the national logistic infrastructures for both the evacuation of injured seafarers and the supply of spare parts to repair damaged vessels is a point that needs to be brought up.

The combination of the remoteness of SAR and huge distances in the Arctic present a significant challenge for coastal states from technical, ecological, and economic viewpoints. Renewing equipment, especially icebreakers especially, is a matter that concerns both navigation safety and the governance of coastal states in their EEZ.

To conclude, if navigation in the Arctic gains in attractivity, there is a great deal to be done in terms of risk handling. Data management remains a key issue. It is currently possible to gather the type of missing data in three categories: geographic, meteorological, and operational. Defining a precise pathway based on climate conditions such as ice thickness is

crucial for vessels to determine their ability to sail within these waters. Data related to the seabed and the existence of sandbanks is also important. Yet, due to the great expanses of the Arctic Ocean, this represents a huge challenge.

Finally, having a comprehensive knowledge and understanding of the different accidents that could occur in the Arctic may support underwriters, classification societies, shipowners, and deck-officers in their decision-making and sailing in safer conditions. If data is a fundamental component of Arctic navigation, coastal states can offer shelters to vessels, limit their remoteness, and increase the density of SAR. While safety has made significant progress in recent years, coastal states must make efforts to mitigate risks to sustain the densification of maritime activity in the years to come.

For a complete analysis, see:
Fedi, L., Faury, O., Etienne, L., Cheaitou, A., Rigot-Muller, P. (2024). Application of the IMO taxonomy on casualty investigation: Analysis of 20 years of marine accidents along the North-East Passage, *Marine Policy* (162), 106061.

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Ports as interfaces of responsible global supply chains

Expert article • 3774

A seaport is not only an interface between land and sea, but also an interface between different production locations, markets, and geopolitical regions. Beneficial cargo owners that wish to transport their goods worldwide depend on the capabilities of seaports to provide seamless transport and logistics. At the same time, there are other stakeholders, including authorities and non-governmental organizations, that have a keen interest in the workings of global supply chains. Seaports can define their role as interface in facilitating trade and logistics that is efficient, safe and secure, and responsible.

Role of seaports in global supply chains

Business, in its continuing strive for efficiency and customer value creation, has globalized its operations and markets. Seaports and maritime operators have developed their role as facilitator by offering very efficient and highly standardized transportation and logistics services.

However, seaports not only act as logistics interface between land and sea, but are also gateways to markets. Supervisory authorities that protect these markets, such as Customs and Food Safety Agencies, scrutinize import shipments that cross borders by profiling the cargo. With millions of containers passing through major sea ports on a yearly basis, this is a daunting task. Risk analysis therefore progressively relies on digital systems that make use of supply chain data. This is needed to detect illegitimate trade associated with drugs trafficking and counterfeit, for example, but it also helps to detect goods that do not comply with environmental or social regulations, such as the Corporate Sustainability Reporting Directive.

Impact of geopolitical events

Several geopolitical developments have negatively affected global trade and logistics in various ways. Impacts of violent conflicts include disablement of production facilities, and blockage of trade corridors. Other impacts are important shifts in trade caused by sanctions and economic conflicts that are triggered by geopolitical tensions. Global supply chains are vulnerable to such disruptive events, of which the impacts may be difficult to identify, let alone anticipated. Important reason for that is the lack of visibility in supply chains: It is not uncommon for a manufacturing firm in a supply chain not to know its indirect upstream supplier base. So, if supply gets disrupted upstream, the downstream firm may not immediately realize it will be affected, as it is unaware of its dependency on that particular source.

Focal firms, such as product brands and retailers, seek to be in control of their supply chains. Example measures are near-shoring and friend-shoring, where suppliers are selected that are closer by or where sourcing is less likely to be affected by geopolitical tensions. Focal firms may also choose to redesign their product assortments in such a way that they become less dependent on scarce raw materials or components with uncertain supply.

Supply chain complexities

Global supply chain risks remain elusive due to complexities. An important driver of complexity is the size and structure of the supplier network. Each of the buyer-supplier relationships in the network by itself introduces complexities, where proper supplier management creates competitive advantage. Also the dynamics of business processes involved introduce complexities. These complexities hinder the effectiveness of (digital) tools in establishing supply chain visibility. For instance, Blockchain enabled tracking and tracing solutions may fail miserably when product from various sources is mixed at a processing stage, or when the number of suppliers is extremely large, as is the case in many agricultural commodity supply chains. So, focal firms either need to reduce the complexities of their supply chains or develop visibility systems that address those complexities properly.

The road ahead

Ports have an important role to play in this matter. On first sight, the scale of port and maritime operations, in which many thousands of supply chains are involved, may seem to render such role infeasible. However, involvement in such a rich ensemble of supply chains also offers opportunities. Port operators and shipping liners that operate globally have started to explore these opportunities and seek 'customer intimacy' with beneficial cargo owners.

A potent mix of information technologies and business concepts that enable differentiation in port and maritime services tailored to individual supply chain needs seems the way forward. The aggregate of data associated with trade and logistics through a main port presents opportunities to learn patterns that help identify and verify product origins, supply chain sourcing opportunities, and various supply chain complexities and risks. Such data is not freely available and access will need to be earned by providing services that transform data into business value.

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An emerging 'Le Havre- Gdańsk range' in the European container port system

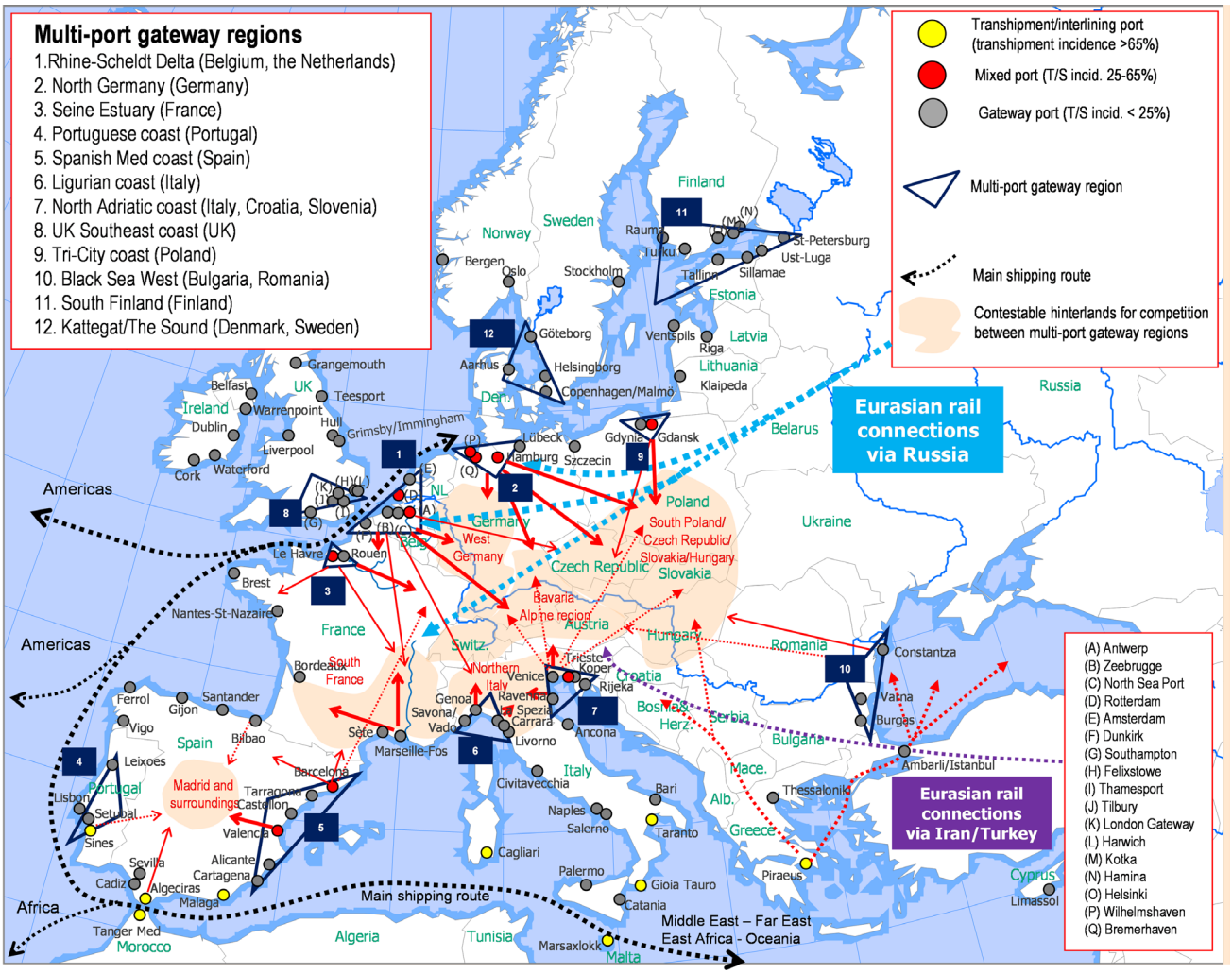
Expert article • 3775

The notions of port system, range and multi-port gateway region

A port system is a network of two or more ports located close to each other within a specific area. Various spatial and functional scales can be identified, ranging from entire coastlines—such as the West Coast of North America, which can be considered one port system—to concepts like the 'range' and the 'multi-port gateway region'.

Figure 1. Multi-port gateway regions in the European container transport system

Note: Transshipment incidence refers to the share of sea-sea transshipment (container arrives by vessel and leaves by another vessel) in total container traffic handled at the port.



A *multi-port gateway region* refers to a smaller geographical scale compared to a container port range. The triangles in Figure 1 provide an overview of the multi-port gateway regions in the European container port system. One criterion used to group adjacent container ports into the same multi-port gateway region is their locational relationship to nearby, identical traffic hinterlands. Additionally, the port calling patterns within the liner service networks and the connectivity profiles of the hinterlands can assist in categorizing ports into a multi-port gateway region. A *port range* refers to a group of container ports located along the same coastline that share a similar inland service area, commonly known as a shared or overlapping hinterland. A widely cited example of this is the Le Havre-Hamburg range in Europe. Within these container port ranges, there is usually intense competition among the ports. A container port range can encompass several multi-port gateway regions. For instance, the Le Havre- Hamburg range includes the multi-port gateway regions of North Germany, the Rhine-Scheldt Delta, and the Seine Estuary in France.

The Tri-City multi-port gateway region in Poland

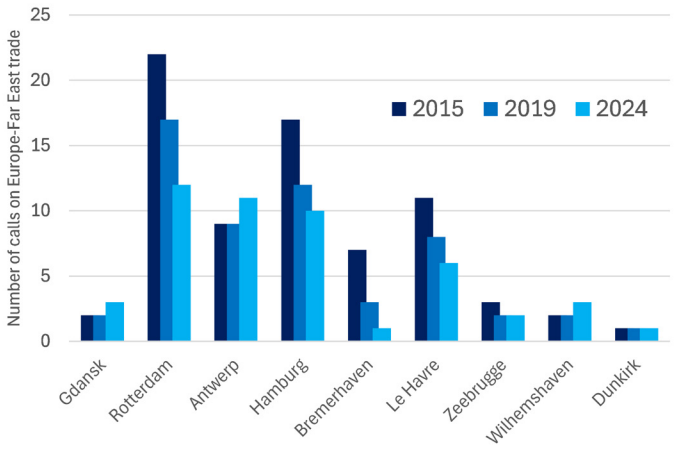
In container traffic, the Polish ports of Gdańsk and Gdynia can be considered part of the same multi-port gateway region, which we can refer to as the Tri-City multi-port gateway region. This area, known as TrójMiasto in Polish, is located in northern Poland and comprises three neighboring cities: Gdańsk, Gdynia, and Sopot, two of which host large seaports.

The Tri-City multi-port gateway region has generally been considered part of the container port system in the Baltic Sea. Several decades ago, this container port system had very few direct mainline vessel calls operating on the major East-West trade routes, specifically between Europe and the Far East and trans-Atlantic routes. At that time, the region primarily consisted of smaller container ports that relied on larger ports in the Hamburg-Le Havre range to connect with major markets in Asia and North America. This reliance allowed ports like Hamburg and Rotterdam to establish a dominant position as sea-sea transshipment hubs within extensive hub-and-spoke networks, which facilitated the connection between mainline services and feeder ships serving the Baltic region.

However, this situation began to alter about 15 years, significantly influenced by the development of the DCT Gdansk terminal, which was renamed to Baltic Hub in 2023. The deepwater terminal started its operations in 2007. While the terminal specialized in servicing feeder ships during the first years of operation, large container vessels operational on the Europe-Far East trade started calling Gdańsk in early 2010. By 2011, Maersk Emma class container vessels with a capacity of 15,500 TEU became regular visitors of the terminal with a further upgrading to Triple E class vessels with a capacity of 18,000 TEU in 2013. In 2015, the terminal position strengthened to two weekly direct Far East calls: the AE10/ Silk service by 2M (Maersk and MSC) and loop 7 by the then operating G6 alliance (APL, Hapag-Lloyd, HMM, MOL, NYK and OOCL). By 2024, the number of direct calls to the Port of Gdańsk had increased to three. Figure 2 illustrates that from 2005 to 2024, Gdańsk successfully raised its number of weekly calls, while most other ports experienced stabilization or decline in call numbers. This decline was partly due to the increasing size of vessels, which now exceed 24,000 TEU on the Europe-Far East route.

The direct connections with Asia significantly boosted container volumes at the terminal, making Gdańsk one of the fastest-growing container ports in Europe. In 2023, the port handled over 2 million TEU, ranking it as the 14th largest container port in Europe by volume. Initially, the terminal relied heavily on sea-to-sea transshipment, with up to 65% of its total volume linked to maritime connections with other Baltic ports. However, in recent years, the share of hinterland gateway cargo has increased considerably, driven by the rapid growth of the East and Central European hinterland regions. To accommodate the rising volumes, the port opened a second deep-water container quay in 2016, and a third extension is set to be completed in 2025. This latest expansion will increase the terminal's capacity to 4.5 million TEU, making it the largest container facility in the Baltic Sea by a significant margin.

Figure 2. Number of weekly container vessel calls on the Europe-Far East trade



The 'Le Havre-Gdańsk range' as a new reference range

It was mentioned earlier that the 'Le Havre-Hamburg range', a network of ports situated along the coastline between Le Havre (part of HAROPA) in France and Hamburg in Germany, has traditionally been the focus of port competition analysis in northwestern Europe. We argue that, as ports in the southern Baltic region gain prominence, it is becoming increasingly important to expand this range to include Polish ports. In this context, we refer to the area as the "Le Havre-Gdańsk" range.

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Figure 3 illustrates the market shares of all ports within the specified range. The spectacular rise of the Tri-City multi-port gateway region since 2009 is clearly evident in the graph. Gdansk and Gdynia combined handled almost 7% of the range's total throughput, a substantial increase from only 1.8% in 2009. The increasing trend in the line graph for Polish ports sharply contrasts with the situation for the German ports of Hamburg and Bremerhaven.

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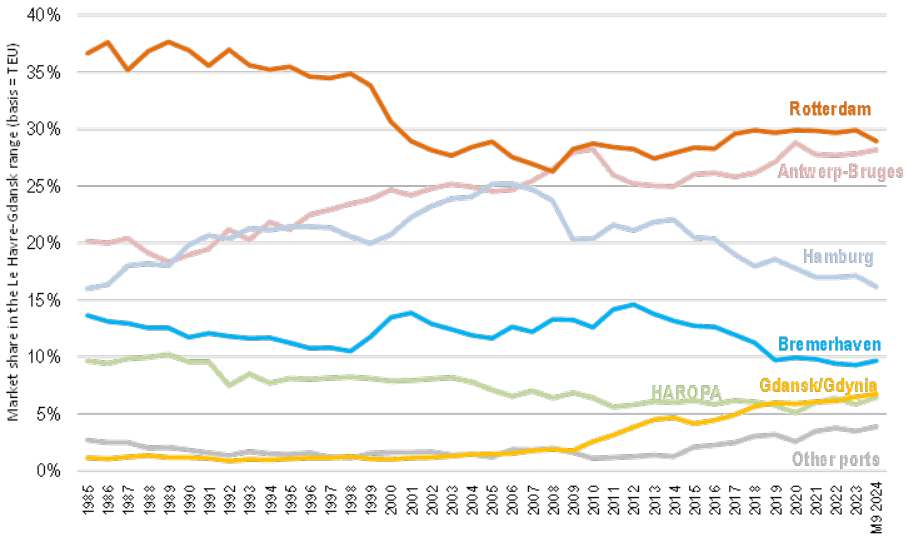
Figure 3. Ports shares in total container throughput of the Le Havre-Gdansk range (1985-2024, based on TEU)



Note: other ports include Wilhelmshaven, Dunkirk, North Sea Port and Amsterdam.

TADEUSZ PALMOWSKI

Port Gdańsk - a logistic and energy hub

Expert article • 3776

Ports are a key link in the logistic chain and play an important role in international economy. Seventy six ports are located round the Baltic Sea. Ports, apart from their economic effectiveness, bear growing responsibility for a friendly attitude towards the environment and society. The future of ports in the Baltic Sea region (BSR) is affected not only by regional links and mutual interdependence but also by economic development trends, politics and global balance. The consequences of climatic changes, fluctuating social values and behaviours, technological innovations, variations in energy supplies and consumption, macroeconomic development, geopolitical situation and a new approach to security and stability all bear a significant impact on the operation and development of Polish ports. This means focusing not only on sustainable solutions and emphasis on a green and blue economy but also on energy and transport issues.

Four Polish ports: Gdańsk, Gdynia, Szczecin and Świnoujście remain of basic importance to the economy. They thrive to strengthen and maintain their position among the seaports of the Baltic Sea basin. Their role is to operate as key hubs, global delivery chains to Central-Eastern Europe and augment better social and economic development of Poland. In the passing decade, their position among European ports has clearly risen.

Port Gdańsk, as an economic body with exceptional development potential, has taken good advantage of its time. During the past few years the port underwent transformation from a baulk cargo facility to a universal port offering berths to the largest ships sailing on the Baltic Sea. The deepwater container terminal Baltic Hub (former DCT) started operating in 2007. Following the construction of a second deepwater quay T2, Baltic Hub doubled its handling capacity in 2016 to 2.9 mil TEU, thus becoming the biggest container terminal in terms of handling capacity on the Baltic Sea. The operating surface spreads to 88 ha. In 2023, the port handled 2.05 mil TEU. At the end of 2024, finishing works took place on the installation of powerful STS quey cranes at yet another terminal T3, which covers an area of 36 ha and provides additional handling capacity of 1.5 mil TEU. The completion of the investment project will raise the handling capacity to nearly 5 mil TEU.

The next investment project of the Baltic Hub will be terminal T5 covering an area of 21 ha, which will serve as a deepwater Offshore Wind Installation Base (OWIB). T5 is to be the extension of the present T1 terminal. The location of the installation terminal in Gdańsk is focal in developing the delivery chain for offshore wind farms in Polish marine areas. The most noteworthy devised undertaking is the construction of the Central Port in Gdańsk. The port is to be built in the Gdańsk Gulf waters. It will be connected to the already existing road and rail infrastructure. Central Port shall cover an area of 500 ha and house 8 terminals and the potential to handle annually even 100 mil tons of cargo. The Port will be built and financed under the public private partnership formula. The investment project is already arousing considerable interest. Implementation of the Central Port project will affect the quality of Port Gdańsk infrastructure and the services it provides.

Still another project involves the construction of a Floating Storage and Regassification Unit (FSRU) for LNG in the Gdańsk Gulf waters. The 3 km long underwater gas pipeline will connect the terminal with the land base. The new pipeline will distribute gas in the country. In effect, Poland will have its second LNG terminal in addition to Świnoujście, thus marking an important step in diversifying energy sources and transforming the Polish economy.

In the Inner Port, the fairway has been deepened to 12 meters, thanks to which larger ships can call at this part of the port. Five km of existing quays, 7 km of railway lines, 10 km of roads, 4 new flyovers and railway stations were modernised and restructured. Today railway access to the Port has become more ecological, efficient and safe. The implemented investment projects and organizational steps significantly improved the pace of service at the port.

Thanks to Poland's bridging location, Port Gdański similarly as the remaining Polish ports are at the onset of the Baltic-Adriatic and Baltic-Black Sea transport corridors. Following Russia's invasion of Ukraine, Port Gdańsk fared well servicing dispatchers from Ukraine, handling coal and as part of Military Mobility quickly prepared unloading sites for NATO allied troops.

The Gdańsk Naftoport has already become a fuel hub for the region. It provides refining to both Poland and the neighbouring states. After the expansion, the port will gain an additional berth for hosting big VLCC ocean tankers (over 300 m long and 60 m wide with the draught limited to 15 m), which translates to a maximum cargo batch of approximately 180 thous. tons. The feasible technological capacity of the new berth is approximately 9 mil tons annually.

Today, Port Gdańsk is strategically a significant partner of the European social and economic network. The new vision and prepared strategy for the development of Port Gdańsk up to 2060 is guided by concern for safety and foresees the building of an energy hub on the port premises, Further steps are in progress to prepare the port's operation in line with the demands of blue and green economy and the port becoming a Generation Five seaport.

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ELENA VALIONIENĖ

Baltic seaports' resilience in the context of cargo flow dynamics

Expert article • 3777

The Baltic Sea ports are an essential part of the European maritime transport network, maintaining a stable market share despite economic and geopolitical changes. Between 2005 and 2022, their share in the EU maritime transport market ranged from 22% to 25%, averaging 24%. This is similar to the North Sea, where the market share averaged 26% over the same period and the link between these regions is strong, as the North Sea hosts major gateway ports distribute cargo to Baltic ports via feeder shipping.

The total cargo volume handled by EU ports has remained relatively stable over the years. The overall change from 2005 to 2022 was just 3%, indicating that the maritime transport sector is resistant to internal economic fluctuations. On average, EU ports handled 7 million tons more cargo each year, with the strongest growth in Mediterranean ports, where annual cargo volumes increased by 4.33 million tons per year The Baltic Sea region had the second-highest growth rate, averaging an annual increase of 2.36 million tons. However, the most intense cargo activity in the Baltic region was observed between 2016 and 2019, before closing due to the COVID-19 pandemic. After this, cargo volumes returned to levels similar to those in 2015. Compared to other maritime regions, such as the Black Sea and the Atlantic Ocean, the Baltic Sea maintained a relatively strong position despite external challenges.

The structure of cargo flows in the Baltic Sea has changed significantly. Liquid bulk cargo volumes have decreased, while dry bulk, containerized, and ro-ro cargo volumes have increased. These factors represent that short shipping tendencies gained intensive growing dynamics. Containerized cargo has shown stable growth, with an averagely annual increase of 1.8 million tons, although this is significantly lower than the Mediterranean, where containerized cargo volumes have risen averagely by 3.37 million tons per year. The share of liquid bulk cargo in Baltic Sea ports dropped from 42% in 2005 to 31% in 2022. Meanwhile, ro-ro cargo expanded from 11% to 17%, and containerized cargo increased from 9% to 13%. Despite EU sanctions on Russian and Belarusian goods, the share of dry bulk cargo in Baltic ports remained stable, excluding some eastern Baltic ports. This resilience highlights the adaptability of ports in Lithuania, Poland, and Germany, which diversified their cargo handling operations to compensate for losses in trade with Russia and Belarus.

Baltic Sea ports have demonstrated significant resilience to external disruptions, including the COVID-19 pandemic and geopolitical instability. In 2020, ports' activity temporarily declined due to pandemic-related restrictions, but by 2021, volumes had already surpassed pre-pandemic levels. This suggests that ports, as key components of global supply chains, can adjust quickly to shifting conditions. However, the 2022 geopolitical crisis, particularly the war in Ukraine and the resulting sanctions, led to fluctuations in cargo flows. Despite these challenges, ro-ro cargo continued to grow at an average annual rate of 0.83 million tons. The impact of these changes was not uniform across the Baltic region, as Scandinavian ports maintained relatively stable cargo volumes, while Eastern Baltic ports experienced more pronounced shifts due to their reliance on Russian trade.

Polish and Lithuanian ports have gained the most significant expansion in the Baltic region. The volume of cargo handled in Klaipėda increased by 181% between 2005 and 2022, while Polish ports recorded a 124% rise. These figures indicate substantial growth and structural development in both countries. Additionally, Polish ports have played a crucial role in facilitating bilateral short-sea shipping trade between Baltic ports within the Baltic Sea region.

Cargo volumes exchanged between Polish and Lithuanian ports, as well as other Baltic ports, have grown steadily, reflecting an increase in regional trade flows. Meanwhile, the cargo volume handled between Polish and North Sea ports increased by 90%, while Lithuania recorded a 25% grow in cargo traffic with North Sea ports. In contrast, Estonian and Latvian ports have experienced a relative decline in cargo handling, indicating shifts in the regional distribution of maritime trade. These changes suggest a growing concentration of cargo flows in the southern Baltic region, particularly in Poland and Lithuania, as they strengthen their role as key hubs for Baltic-Baltic short-sea shipping and broader European maritime connections.

The importance of the Baltic-Adriatic (5th TEN-T) transport corridor has grown considerably. Short-sea shipping between Lithuanian and Mediterranean ports increased by 248% between 2005 and 2022, while Polish ports recorded a 197% rise. The most substantial expansion was seen in Denmark, where short-sea shipping volumes with Mediterranean ports grew more than four times. Strengthening these connections allows Baltic ports to compensate for lost trade with Eastern countries involved in geopolitical crisis and ensures the long-term sustainability of cargo flows in the region.

Baltic Sea ports continue to adapt to changing market conditions, reinforcing their role in European maritime trade. Their growing integration with North Sea, Mediterranean transport networks supports long-term stability, helping to balance fluctuations in regional trade. While Scandinavian Baltic ports tend to maintain stable cargo handling level and demonstrating high resistance in the terms of resilience, Eastern and Southern Baltic ports demonstrate faster response and flexibility in responding and adoption to economic and geopolitical challenges. Stronger connections between Baltic ports and other European maritime regions ensure that they remain key players in international trade, capable of withstanding both economic uncertainty and geopolitical tensions.

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ROBERT PHILIPP

The underestimated role of small ports

Expert article • 3778

Ports are the backbone of the transport network, without which the worldwide economy could not exist in its present form. If all economic activities that depend on the sea are cumulated, the so-called Blue Economy of the European Union directly employs about five million people and generates around 750 billion EUR in turnover and over 200 billion EUR of gross value added. Seaports represent the main hubs for commercial activities. 70% of all goods are transported to or from ports outside the EU-27, making Maritime Transport the most important mode for long distances, while cargo transport between ports in the EU-27 makes up 27%. Every year, more than four billion tonnes of freight and more than 400 million passengers pass through the 1,200 European ports.

However, the focus of policy makers has been primarily on large ports. Hence, small and medium-sized ports are often underestimated and neglected, which is discernible by different small port closures (Friedrichskoog in Germany, Stigsnæsværkets in Denmark, etc.) and the Trans-European Transport Network (TEN-T) regulations. Regarding the latter, the European Commission, within the issued guidelines for the development of the TEN-T, identified 329 key ports along the European coastline that are slated to become part of a unified network for boosting growth and competiveness in Europe's Single Market. The TEN-T will be double-layered; it will consist of a core network (planned for 2030) and a comprehensive network (planned for 2050). Inside the core network, nine corridors are planned, which will be multi-modal and intended to improve cross-border links (road, rail, waterways) within the EU. In this context, European ports are differentiated between core ports, comprehensive ports and non-TEN-T ports. Large ports are in the category of core ports, while medium-sized ports are classified as comprehensive ports. However, small ports are not directly considered within the development plans of the TEN-T, which equals around 900 non-TEN-T ports.

Paradoxically, as outlined by the EU-project Connect2SmallPorts (INTERREG V A), conducted between 2018 and 2022, small ports are also the collectors and repositories of knowledge and ideas and thus constitute the hubs of regional economies that are important gateways for regional development. Hence, small ports are crucial logistics hubs and germs of logistics clusters that contribute substantially to regional development.

In 20212, the European Commission defined the European Blue Growth Strategy, which targets to support sustainable growth in the marine and maritime sector. The European Commission has emphasised in the framework of the Blue Growth Strategy that seas and oceans are drivers for the European economy, with a great potential for innovation and growth. The underlying established sectors include among other things "Marine Living Resources", "Marine Non-living Resources", "Marine Renewable Energy", "Shipbuilding & Repair", "Maritime Transport", "Coastal Tourism", etc.

In the frame of EU-funded project INTERMARE South Baltic (INTERREG V A), which took place between 2017 and 2021, for the very first time, the future Blue Growth potential was investigated and quantified through a conducted forecast analysis. The results revealed among other things that it is important to promote especially the Maritime Transport sector in order to foster Blue Growth in the South Baltic Sea Region. The findings suggest that policy measures should seek to further promote network activities within the blue sector in the South Baltic Sea Region, i.e. especially increase the integration of the identified sectors in the course of cross-border network activities in the region, in order to stimulate Blue Growth. Deeply rooted in the fact that ports are the central hubs and nodes in diverse supply chains in the maritime transport sector, their actions within change management have enormous and far-reaching spillover effects. Ports are the essential and dominating players in the global transport system, which connotes that innovative changes in ports affect the entire economic environment. Hence, their failure or success has a tremendous and multi-layered impact on the different Blue Economy sectors, as well as on all further linked industries, and thus on the economic growth and prosperity in the corresponding regions. This circumstance, as well as the fact that 66% of all Baltic Sea Region seaports are small and medium-sized ports, pleads for a stronger concentration of smaller ports within future policy agendas that target to foster spatially inclusive and comprehensive Blue Growth. Accordingly, without the inclusion of small and medium-sized ports, the idea of further developing and safeguarding a still competitive European Single market remains unachievable.

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Ports heading for sustainability

Expert article • 3779

Maritime transportation is crucial for life and business around the Baltic Sea. However, the transport sector emits greenhouse gases such as carbon dioxide (CO2), which significantly contribute to the climate crisis. To address this challenge, shipping and port operations must transform to become environmentally, economically, and socially sustainable. Ports play a key role in reducing CO2 emissions and advancing this transformation.

A cross-border partnership of Finnish (including Åland), Swedish, Estonian, and Latvian organizations is tackling sustainability in ports through the Interreg Central Baltic project Sustainable Flow. Led by Satakunta University of Applied Sciences, the partnership includes Fintraffic VTS, Åland University of Applied Sciences, the Swedish Maritime Administration, the Swedish Confederation of Transport Enterprises (TPF), Tallinn Technical University/Estonian Maritime Academy, and the International Transport Development Association. Together, they bring extensive scientific and practical expertise on ports and sustainability. Seven pilot ports are actively involved, aiming to develop a decision-making tool that offers practical solutions for reducing CO2 emissions in ports and other intermodal or multimodal transport systems.

There is an old saying that once you have seen one port, you have seen only one port—every port is unique. This is certainly true of the Sustainable Flow pilot ports:

- Port of Rauma, Finland
  Owing to significant container terminal investments, Rauma has become the largest container port on Finland's west coast. Shore power and crane power connections are among the reforms supporting its sustainable development.
- Port of Pori, Finland
  Pori's large port area supports the wind power industry, and this role is expected to grow as demand for renewable energy increases.
- Port of Mariehamn, Åland
  Primarily a passenger port with minimal cargo operations, Mariehamn faces the 2030 shore-side electricity mandate for ships, necessitating both grid upgrades and new energy generation solutions.
- Port of Norrköping, Sweden
  As one of Sweden's most vital maritime transport hubs, Norrköping has invested in new cargo-handling facilities and infrastructure. Notable developments include a state-of-the-art container port and a combi terminal.
- Port of Oxelösund, Sweden
  Owned jointly by industrial group SSAB Ltd. and the municipality of Oxelösund, the port's logistics operations offer comprehensive transport-chain solutions. Its strategic location near open sea and an ice-free channel reduces pilotage distances, saves time, and lowers costs.
- Port of Riga, Latvia
  As the largest of the pilot ports, Riga is a multi-purpose hub handling all types of cargo. By 2030, the goal is for 90% of its energy use to come from renewable sources. Its business cluster comprises the port authority and around two hundred private companies.
- Port of Tallinn, Estonia
  One of Europe's largest passenger ports, Tallinn has cargo facilities capable of increasing traffic. It aims for full carbon neutrality by 2050 at the latest.

Despite their different ownership structures and operating environments, all pilot ports share a commitment to a more sustainable future. Meeting the need for sustainable development should be viewed as an opportunity rather than a constraint. Because funding is always limited, investments must be carefully prioritized to yield tangible environmental benefits.

The diversity of the pilot ports—each with its own starting points, ownership models, and operational profiles—ensures that solutions developed are widely applicable. The ultimate outcome of the Sustainable Flow project will be an open-source digital decision-making tool that supports CO2 reductions in ports and related transport systems. By tailoring practical solutions to a broad range of situations, the project will help ports of all sizes work toward a cleaner, more sustainable maritime sector.

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Advancing sustainability skills in EU maritime transportation and logistics

Expert article • 3780

The maritime transportation and logistics sector is a cornerstone of European and global trade, responsible for moving approximately 90% of the EU's external trade and 40% of its internal trade. However, according to IMO (International Maritime Organization) data, its environmental footprint is significant, contributing nearly 3% of global greenhouse gas (GHG) emissions. The sector faces increasing pressure to reduce the effects of air, water, noise, and shipbreaking pollution, as well as reduce waste and habitat destruction. For example, eutrophication mitigation is especially important for the Baltic Sea region. These skills implementation is necessary to adhere to stricter EU environmental regulations such as the European Green Deal and the Fit for 55 package, which encompasses the Zero Pollution Action Plan, the FuelEU Maritime Regulation, the Alternative Fuel Infrastructure Regulation and the extension of the Emissions Trading System (ETS) to maritime transport, and adopt sustainable practices. Addressing these challenges requires equipping maritime professionals with the necessary set of skills, enabling them to implement energy-efficient operations, reduce emissions, and comply with evolving EU and international regulations.

Despite the urgency, gaps remain in the education and training of maritime specialists regarding environmental sustainability. Many existing curricula in European higher education institutions (HEIs) still lack comprehensive modules on sustainability and environmental accountability set of skills, leaving graduates ill-prepared for the sustainable transition. This gap is especially visible when taking into account the future needs of the industry. Additionally, lifelong learning opportunities for professionals already in the industry are limited. Mainly because of the shortage of specialised programmes oriented on maritime professionals, the high cost of training, which is not easy to get for smaller companies or individuals, separate role plays a lack of standardisation and gaps in regulations and policies, as well as limited support from the companies behalf, who are looking for a short-term efficiency over a long-term investments in education.

To successfully integrate sustainability and environmental accountability skills into maritime education, European HEIs need to undergo curricular transformation more efficiently. Current programs focus mainly on traditional supply chains, logistics and maritime commerce, and navigation, often sidelining sustainability. A paradigm shift is necessary, embedding planetary sustainability and environmental accountability competencies into core maritime studies.

HEIs could incorporate modules on sustainable shipping technologies, alternative fuels, carbon footprint reduction strategies, systems thinking, logistics optimisation, and circular economy principles in alignment with EU climate policies. Collaboration with industry stakeholders ensures that educational programs align with real-world sustainability challenges. Institutions such as the World Maritime University (WMU), with their last year Summer Academy course on Maritime Decarbonization, and the European Maritime Safety Agency (EMSA) with offering a toolbox of pollution response services, have already taken steps by offering specialised programs in maritime sustainability, serving as a model for others to follow. However, resistance to change in educational institutions, logistical constraints and shipping industry itself pose challenges. Faculty training, curriculum redesign, and securing industry partnerships require significant investment in both time and resources. Despite these hurdles, the long-term benefits of equipping students with green skills - ensuring compliance with the EU's ETS for shipping and IMO sustainability regulations - outweigh the initial costs.

Due to technological advancements and regulatory changes, the European maritime industry is rapidly evolving, requiring continuous learning among professionals. Traditional degree programs alone cannot suffice, so professionals must engage in lifelong learning to stay updated on sustainable practices. Short-term certification courses, online learning platforms, and professional development workshops play a principal part in bridging knowledge gaps, as well as enabling independent and multiform learning to reach a desired professional set of skills. Initiatives such as the European Green Deal, the EU's Skills Agenda, and the IMO's Maritime Training Program promote lifelong learning by providing resources and structured training programs. Luckily, more and more companies are starting to increase their investment in sustainability training for their workforce, recognising that continuous education promotes compliance and improves work efficiency, which hopefully will make changes in this direction.

EU policymakers, HEIs, and industry leaders must collaborate more to create policies that integrate sustainability into maritime curricula and professional training. For example, in Finland, the Ministry of Economic Affairs and Employment has launched a development programme for sustainable maritime industry in 2022 in cooperation with Business Finland. The programme's coordinated measures aim to use resources more efficiently and increase leverage. Furthermore, standardising green skills training across HEIs in EU member states can create a uniform benchmark, ensuring that maritime professionals possess comparable sustainability competencies.

A multi-stakeholder approach, continued efforts in policy development and industry collaboration are vital for effective sustainability skills implmentation into education of maritime specialists.

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