R&D-Report

Seaports in Northern Norway: Current Challenges and Future Development Strategies

Report 3 of the BEAR Project

RCN/320266

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Seaports in Northern Norway: Current Challenges & Future Development Strategies

Report 3 of the BEAR Project RCN/320266
Business School, Nord University, Bodø
March 2026

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Preface

This is the third of six reports to be generated by the BEAR Project analysing maritime transportation in Northern Norway, a region of profound economic and strategic importance to the whole of Norway. Together, these six reports will contribute to increasing our understanding of maritime activities in the region.

The BEAR Project was made possible through generous funding from the Research Council of Norway (RCN/320266) under the grant "Collaborative and Knowledge-Building Project to Meet Societal and Industry-Related Challenges", with financial support from the Norwegian Ministry of Foreign Affairs.

This collaborative endeavour is led by the Centre for High North Logistics (CHNL) at the Business School of Nord University in Bodø. Project partners include Kunnskapsparken Bodø AS, Akvaplan-niva AS, Tschudi Kirkenes AS, and Sør-Varanger Utvikling AS.

The BEAR Project experienced delays due to the restrictions on travel and meetings imposed during the Covid-19 pandemic. The initial scope of the project also required modification to address changing geopolitical conditions. The project was initially designed to study maritime transport infrastructure across the Barents Euro-Arctic Region (BEAR) and included two university partners in northern Russia. However, the invasion of Ukraine in February of 2022 necessitated a fundamental restructuring of the project's objectives and workplan, including the exclusion of the initial Russian partners.

In response, the project's focus was strategically shifted to a more in-depth study of the maritime transportation and logistics system in Northern Norway. This new scope also includes an assessment of cross-border transport connections with Northern Sweden and Northern Finland, reflecting the new geopolitical and logistical realities in the High North.

We trust that this report, and additional reports that will follow, will provide a robust and essential knowledge base for policymakers, industry stakeholders, and researchers. It is our hope that this work will contribute to the development of a more resilient, efficient, and sustainable transportation system for Northern Norway.

The BEAR Project Team,

March 2026

Executive Summary

This third report of the BEAR Project provides an examination of Northern Norway’s seaport system. The primary purpose is to provide a holistic investigation into the preconditions for an effective port, identify the current characteristics and challenges of the northern seaport system, and create a portfolio of viable, forward-looking development strategies. The study addresses a critical paradox: despite a longstanding national policy goal of promoting a modal shift of freight from road to sea, this shift has largely failed to occur in Northern Norway. Road transport remains the dominant mode, particularly for high-value and time-sensitive goods, leaving the maritime sector in a comparatively weak position. This report, therefore, aims to provide a strategic toolkit for policymakers, port authorities, and industry stakeholders to enhance the efficiency, sustainability, and competitiveness of the region's seaports, thereby enabling them to function as powerful catalysts for regional development and value creation.

a. Preconditions for an effective seaport

Our analysis shows that a successful seaport is a complex ecosystem built on ten interdependent pillars. A favourable geographical location and natural environment (including deep, sheltered waters and available land) are fundamental. The port must be supported by high-quality infrastructure and facilities, a comprehensive range of port services (including value-added services), and high efficiency to minimize costs and vessel turnaround times. Competitiveness also depends on reasonable port fees, strong security, and extensive connectivity to both global shipping routes and inland road and rail routes. The long-term viability of a seaport depends on its development potential, which is in turn dependent on an effective port governance model and a commitment to mitigating negative environmental and social impacts. The weakness of any of these core elements can significantly impair a port's development and function.

b. The Norwegian seaport system

Norway’s seaports have decentralized governance. Most of the 32 national network ports are owned and operated by local municipalities. This grants significant autonomy but hinders strategic coordination at a national level. In Northern Norway, this structure has resulted in a large number of small ports serving a dispersed population. The cargo landscape is overwhelmingly dominated by bulk commodities. Dry bulk constitutes the largest share of goods travelling through these ports, primarily driven by the 21 million tons of Swedish iron ore exported annually via the Port of Narvik. Liquid bulk, mainly LNG from the Port of Hammerfest, is the second-largest category. In contrast, volumes of general and containerized cargo are exceptionally low at most ports, reflecting the region's deep reliance on truck transport for consumer goods and other finished products. Intermodal connections are a profound weakness. Although several key ports have access to the rail network, they lack the efficient ship-to-rail transshipment facilities required to create an efficient intermodal logistics link.

c. Challenges facing seaports in Northern Norway

This project has identified five interconnected challenges that constrain the development of the region's ports. First, demographic challenges, including population decline and an aging

workforce, combined with long distances, create a classic feeder market of many small, low-volume ports. Under these circumstances, achieving economies of scale is difficult. Second, the situation is worsened by limited state funding and decentralized governance. The maritime sector receives a disproportionately small share of national transport funding, while the fragmented, municipality-led governance model fosters competition rather than collaboration. Third, the cargo flow is characterized by high-volume resource exports and low import traffic. Low and imbalanced cargo volumes in coastal shipping led to inefficient, often subsidized, shipping services that cannot compete with the speed and flexibility of road transport. Fourth, many ports suffer from limited services and capacity, lacking modern infrastructure, automation, and essential facilities like refrigerated storage. Fifth, there is a failure of intermodal integration. The lack of true logistics hubs with seamless sea-rail-road connections is a major bottleneck, exemplified by the collapse of the Bodø-Tromsø sea-rail container service, which has reverted entirely to road transport.

d. Development strategies for seaports in Northern Norway

To counter these challenges, this report evaluates a portfolio of six potential development strategies. These range from operational enhancements to fundamental structural changes, and include: (1) Implementing short-sea feeder networks using a "hub-and-spoke" model, incorporating synchronized "mother-daughter" vessel operations and potentially ship-to-ship transshipment at sea, to consolidate cargo and improve service frequency; (2) Positioning ports as “decarbonization centre” for the green transition by investing in shoreside power and alternative fuels; (3) Adopting smart seaport initiatives through digitalization and automation to improve efficiency; (4) Utilize innovative construction techniques like floating port infrastructure (modular caissons) to create new land for port expansion and overcome the region's challenging topography; (5) Develop offshore wind power centers at seaports to support Norway's ambitious renewable energy goals and create new economic opportunities; and (6) Develop major container transshipment hubs (regional logistics clusters) to facilitate the model shift from road to sea. This final strategy is the most transformative strategy, as it involves moving from the current fragmented model to a state-led regional governance model. This would encourage specialization, reduce internal competition, and optimize resource allocation within the entire region.

e. Conclusion

The primary conclusion of this report is that the seaport system in Northern Norway is at a critical crossroads. The current model is unsustainable because of demographic decline, insufficient funding, fragmented governance, inter-port competition, infrastructural deficits, limited port services and cargo handling capacity, and lack of competitive advantages compared to road transport. These challenges are deeply rooted and cannot be solved with minor adjustments; a fundamental shift is required. To unlock their full potential, the region's ports must transition from isolated municipal entities to a state-led regional governance model. This transition would involve the creation of a network of state-supported regional logistics clusters that incorporate both local municipalities and key industrial stakeholders to ensure strategic alignment and access to funding. This approach would allow the system to achieve necessary economies of scale, foster specialization based on regional industrial strengths, and enhance overall competitiveness. By doing this, the new approach may finally enable the modal shift of cargo from road to sea and position Northern Norway's ports as drivers of sustainable economic growth.

1. Introduction

The BEAR Project will produce six reports dealing with maritime activities in Northern Norway (*Table 1*). The first three reports cover transport-intensive industries and the maritime cargo base (Report 1); the maritime transportation and logistics system (Report 2); and seaports (Report 3). All three reports were completed at the same time, relying on the same quantitative and qualitative datasets and applying a mixed methods analysis approach.

Table 1: The six reports of the BEAR Project

Report No.	The BEAR Reports:
1	"Transport-Intensive Industries and the Maritime Cargo-Base in Northern Norway", published in March 2026.
2	"Maritime Transport and Logistics in Northern Norway: Current and Future Development", published in March 2026.
3	"Seaports in Northern Norway: Current Challenges and Future Development Strategies", published in March 2026.
4	Environmental risks of shipping and port activities in Northern Norway (working title).
5	Maritime intelligent transportation systems: Emerging technologies and their applicability for Northern Norway (working title).
6	The significance of effective transport systems for regional socio-economic development in Northern Norway (working title).

1.1. Background

For a country like Norway, with one of the world's longest coastlines, maritime transport is an essential part of the national transport system. Norway's economic development is highly reliant on its ability to export key goods and resources efficiently by sea. The industries relying heavily on maritime transport include oil and gas, fisheries, aquaculture, and mineral extraction. As the interface between maritime and land-based transport, seaports facilitate freight movement and serve as gateways for Norwegian exporters.

The seafood sector relies heavily on ports. In 2024, a total of 2.8 million tonnes of seafood worth NOK 175.4 billion was exported.[1] While a large amount of exported seafood is transported by truck to European markets, seaports still play a significant role in the logistical chain. Ports facilitate the landing of wild-caught fish and import of feed and equipment for aquaculture. For frozen seafood destined for overseas markets in Asia and the Americas, maritime transport from ports like Tromsø is the only viable option. In addition, the energy and minerals sectors are entirely dependent on maritime transport. For example, the Port of Hammerfest is a major export point for LNG and the Port of Narvik for the export of iron ore. This reliance on the port system makes its efficiency, capacity, and connectivity to global markets important factors influencing nearby economic activities.

Alongside their role in international trade, seaports also connect Northern Norway's coastal communities. They ensure that remote communities receive essential supplies, from consumer goods to construction materials. Sea transport is sometimes the only means of cargo transport because of geography and/or winter road closures.

The significance of seaports in Northern Norway continues to increase thanks to their core role in the green energy transition. The Norwegian government's ambition is to develop offshore wind power production capable of generating 30,000 MW by 2040.[2] This development will rely on seaports as bases for construction and maintenance. Furthermore, growing geopolitical interest in the Arctic increases the strategic importance of Northern Norway's seaports, with the ports becoming key infrastructure for both civilian and military preparedness and national security.

Despite broad recognition of this growing importance of seaports and maritime transport, the proportion of cargo exports from Northern Norway which use maritime transport is declining. In recent decades, Norwegian and EU policies have aimed to promote a modal shift, encouraging the transfer of freight from road to sea and rail. The driving factors of these policies are environmental sustainability, traffic safety, and road infrastructure preservation. However, the achievement of this policy in Northern Norway is limited. Road transport often remains the preferred mode, particularly for high-value, time-sensitive products like fresh seafood, due to its flexibility and short lead-time.

1.2. Significance of the study and identified research gaps

This study addresses a significant research gap in the existing literature by providing a comprehensive investigation of the seaport system in Northern Norway. In contrast, previous studies of Norwegian seaports have generally focused on a singular aspect of the port system, such as port number rationalization,[3] decarbonization approaches,[4] or feeder network

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[1] Martin Skaug, "2024 was the best year ever for Norwegian seafood exports," en.seafood.no, updated n.d., 2025, accessed 09.11, 2025, https://en.seafood.no/news-and-media/news-archive/2024-was-the-best-year-ever-for-norwegian-seafood-exports/.

[2] Regjeringen, Ambitious offshore wind initiative, regjeringen.no, 2022.

[3] Morten Svindland, Jason Monios, and Harald M Hjelle, "Port rationalization and the evolution of regional port systems: the case of Norway," *Maritime Policy & Management* 46, no. 5 (2019).

[4] Markus Steen et al., "Implementing decarbonisation measures in Norwegian ports," *Transportation Research Interdisciplinary Perspectives* 23 (2024).

designs.[5] There is a lack of research that takes a holistic approach to examining the preconditions for effective seaports, current challenges, and forward-looking development strategies.

The primary significance of this research lies in its integrated approach. It moves beyond a singular focus on policy design or infrastructure configuration, exploring the complex interaction among factors that determine the success and sustainability of the port system in Northern Norway. A key finding emerging from this approach is that the decentralized governance model for the ports prevents the strategic cooperation needed to secure state funding. This lack of funding and coordination also makes efficiency-enhancing strategies like logistics clusters unfeasible, undermining the ability to plan, fund, and execute the development of seaports in the region.

In addition, previous research on port development has typically used a single port as a case study to provide a solution for a single problem.[6] There has been a lack of systematic exploration of a diversified portfolio of strategies appropriate for the variety of seaports in Northern Norway. This study evaluates a range of specific, innovative development solutions. These include optimizing feeder networks; positioning seaports as hubs for the green energy transition (e.g., decarbonization, offshore wind); leveraging smart technologies,; and fostering regional logistics clusters. By highlighting this range of strategies, this project provides a strategic toolkit for policymakers, port authorities, and industry stakeholders.

1.3. Research questions

To guide this comprehensive investigation, Report 3 of the BEAR Project is structured around three central research questions that address the preconditions, challenges, and strategies for port development in Northern Norway: (1) What preconditions need to be met for a port in Northern Norway to develop into a major logistics centre, providing key transport, storage, and transshipment services and promoting business and industrial activities? (addressed in Section 3); (2) What are the current challenges for the development of seaports in Northern Norway? (addressed in Section 6); (3) What are some strategies which hold significant potential for the development of seaports in Northern Norway? (addressed in Section 7). By answering these questions, this report aims to provide a robust analytical foundation for enhancing the role of seaports as catalysts for regional development and value creation.

1.4 Structure of the report

The remainder of this report is organized to systematically address the above research questions. Section 2 outlines the analytical methodology employed in the study, detailing the combination of qualitative and quantitative approaches used to gather and interpret data, including a review of existing literature, analysis of national transport statistics, and insights from stakeholder interviews. Section 3 examines the preconditions for an effective seaport. Section 4 provides a detailed overview of the Norwegian seaport system. Section 5 narrows

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[5] Mohamed Kais Msakni et al., "Analyzing different designs of liner shipping feeder networks: A case study," *Transportation Research Part E: Logistics and Transportation Review* 134 (2020).

[6] Andreas Breivik Ormevik, Stein Ove Erikstad, and Kjetil Fagerholt, "Evaluating port development strategies for a modal shift: a Norwegian case study" (paper presented at the International Conference on Computational Logistics, 2020).

the focus to the seaports in Northern Norway, providing an analysis of ports by their importance, cargo types, role in international trade, services provided, existing intermodal connections to road and rail networks, and development plans. Section 6 discusses the primary challenges facing seaports in Northern Norway. These challenges are identified based on face-to-face interviews with several maritime stakeholders. Section 7 explores a range of potential development strategies designed to address the identified challenges and leverage regional opportunities. Finally, Section 8 presents the study's overall conclusion and Section 9 offers a set of strategic recommendations for policymakers, port authorities, and private sector stakeholders aimed at fostering a more efficient, sustainable, and competitive seaport system in Northern Norway.

2. Methods of Analysis

2.1 Research design: mixed-methods approach

There are typically two types of research methods in maritime logistics and regional development: the positivist quantitative approach, which makes use of metrics such as throughput in Twenty-foot Equivalent Units (TEUs) and infrastructural capacity, and interpretivist inquiry, which seeks to understand the strategic decisions, governance challenges, and institutional bottlenecks perceived by human actors. To fully address the research questions regarding preconditions for effective ports, current challenges, and future development strategies, this study adopts a mixed-methods research design incorporating elements of both of these approaches.[7]

In this model, quantitative and qualitative data are collected simultaneously but analysed separately before being merged during the interpretation phase (i.e., in the development of strategic recommendations). The choice of this design is justified by the need for complementarity. Quantitative data from national statistics provides a generalized overview of trends (the "what"), while qualitative data from interviews provides the depth, context, and causal mechanisms (the "why"). This design allows the research team to triangulate findings, ensuring that the strategic recommendations are not based on isolated statistics or single sources of evidence, but on confirmed evidence from multiple sources.

The research team collected data from four sources: online statistical databases, publicly available information from industry websites, semi-structured interviews with maritime stakeholders, and existing literature and official documents.

2.2 Quantitative data collection

Quantitative analysis of online databases. Quantitative data forms the empirical backbone of this report, providing a statistical overview of port activities in Northern Norway. The primary source for this data was Statistics Norway (SSB), which offers detailed datasets on cargo throughput by type of cargo, vessel calls, and international trade volumes. This data is used to

[7] Leedy, P.D. and Ormrod, J.E., 2015. *Practical research*. Pearson Education UK.

rank ports, identify key cargo flows, and analyse the distribution of maritime traffic across the region, as detailed in Section 4.

Review of online sources. To supplement this statistical data, a review of publicly available online information was also conducted. This involved examining the official websites of individual port authorities, shipping lines, logistics companies, and major industrial actors in Northern Norway. This review provided crucial information on port facilities, available services, fee structures, ongoing and planned infrastructure projects, and strategic development goals. This data helped to build a detailed profile of each port's operational capabilities and ambitions.

2.3 Qualitative data collection

Qualitative data from semi-structured interviews. To complement the quantitative data and obtain opinions from professionals in the maritime sector, a series of semi-structured interviews were conducted with key stakeholders across Northern Norway. This qualitative approach is essential for understanding current challenges, operational bottlenecks, investment decisions, and the underlying reasons for specific logistical choices. This information is not apparent in statistical data. Our 43 interviewees (informants) are upper-management level professionals representing port authorities (PA), logistics service suppliers (LS, RL; transport companies), cargo owners (CO), business networks (BN), energy utilities (EU), maritime industry (SY3), and the government (GA) (see *Table 2*).

A semi-structured interview approach ensures that core questions across all interviews conducted by research team members at different locations, while also providing interviewers with the flexibility to ask follow-up questions and dig into specific topics relevant to each stakeholder. Interviews were recorded and transcribed to provide the authors of this report with rich contextual narratives and an understanding of the maritime industry. The interview data serves as the foundation for the report's findings and recommendations. To maximize research efficiency and minimize "respondent fatigue," the data for this report was collected at the same time as the data required for BEAR Report 2. Both reports draw on the same pool of anonymized semi-structured interview data.

Document and literature review. Finally, a review of existing documents and academic literature was performed to contextualize the other three datasets. This included analysing national policy documents such as the National Transport Plan, reports from the Norwegian Coastal Administration, and relevant industry studies. All policy documents were critically assessed for authenticity and representativeness to ensure that they reflect current official policy. The academic literature review focused on topics such as port governance, logistics cluster theory, short-sea shipping models, and smart port development. This review provides the theoretical framework for the analysis in this project.

2.4 Ethical considerations and data management

The project adheres to ethical guidelines and complies with Norwegian law and institutional requirements.

Notification and privacy: The project's data processing activities were reported to the Norwegian Agency for Shared Services in Education and Research (SIKT, formerly NSD). A

Data Management Plan (DMP) was developed to ensure the secure handling of data throughout the project lifecycle.

Informed consent: Informed consent was obtained from all interview participants. Participants were informed of the project's purpose, funding, and their right to withdraw at any time, ensuring compliance with ethical standards for research involving human participants.

Confidentiality: All personal data, including audio recordings (using the Dictaphone app), are stored on secure servers on the nettskjema.no platform. In the final report, data is presented in an anonymized or de-identified format to protect the privacy of individual stakeholders.

Table 2: Stakeholders in Northern Norway participating in interviews

Type of organization	Number of interviews	Codes of transcribed interviews
Port authority	13	PA5, PA6, PA7, PA13, PA14, PA15, PA16, PA17, PA18, PA19, PA21, PA22, PA23
Logistics supplier (transport company)	15	LS1, LS2, LS4, LS12, LS14, LS15, LS18, LS20, LS21, LS23, LS24, LS25, LS27, RL1, RL2
Cargo owner	7	CO1, CO9, CO17, CO20, CO21, CO23, CO25
Business network	4	BN10, BN14, BN16, BN17
Energy utility	2	EU8, EU15
Maritime industry	1	SY3
Government	1	GA11

3. Preconditions for an Effective Seaport

3.1 Geographical location and natural environment

The geographical location of a port is of fundamental importance to its commercial sustainability. Ports located close to highly populated areas and regions with large industrial production can rely on steady customer base and large transport volumes. The same cannot be said for ports located in regions with low populations and industrial activities, far removed from main trading routes and regional markets. Such ports are commonly characterized by low cargo volumes and infrequent transport services. A port’s geographical location can also dictate the level of access it provides to the hinterland,[8] and this connection to the hinterland is often considered, along with the quality of land-based transport, when port users choose specific ports for their operations.[9] Meanwhile, geographical features like the long coastlines and numerous small islands found in fjord landscapes can make the distance between the origin and destination ports significantly shorter by sea than by land, benefitting maritime transportation.

Several natural features can also have impact on ports and impair their growth and efficiency. These include insufficient water depths for handling larger vessels and lack of natural shelter against high winds and heavy seas. Larger vessels also require a safe area to maneuver within the extended port area. Other possible natural constraints include large tidal ranges, which create challenges for the loading and unloading of cargo, especially roll-on-roll-off cargo.[10] Restricted navigable periods due to severe winter weather and sea ice is also a concern. Northern Norway's harsh climate is one of the major obstacles preventing efficient cargo flow in the region,[11] with shipping companies sometimes cancelling port calls entirely when the weather is very challenging.[12]

Ports can also be impacted by a lack of land for construction and future port expansion. Our informants emphasized the importance of having available land adjacent to quays to improve logistics operations.[13] Hard bedrock and elevated topography around port areas makes construction difficult and expensive. Another common issue is the growth of some port cities, which results in competition with residential development for use of suitable land. These are common constraints for many larger Norwegian ports.[14] As an example, to address these challenges, it was decided by the municipal government to move the main cargo terminal of the Port of Bergen from the city centre to the nearby Agotnes region.[15]

A good geographical location is critical for a port to develop into a strategic logistics hub.[16] One of our informants pointed out that the Port of Harstad in Northern Norway benefits from being centrally located among other major ports like Bodø and Tromsø, and also a relatively short drive from Lofoten and Vesterålen. Similarly, the Port of Berlevåg is strategically positioned, offering the shortest route to Longyearbyen from mainland Norway.[17] Other Norwegian ports located further south, bordering the Skagerrak inlet and the North Sea – including ports in the Oslo region (Oslo, Moss, Larvik, Drammen, Grenland), Kristiansand,

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[8] The area inland from a port is referred to as "hinterland," which is defined as “organized and developed land space which is connected with a port by means of transport lines, and which receives or ships goods through that port.”
[9] Jose L Tongzon, "Port choice and freight forwarders," *Transportation Research Part E: Logistics and Transportation Review* 45, no. 1 (2009).
[10] Informant LS2 (2022).
[11] Informant LS1 (2022).
[12] Informant BN16 (2022); Informant CO17 (2022).
[13] Informant PA19 (2023); Informant CO25 (2023).
[14] KL Rødseth, PB Wangsness, and KR Klaboe, "Marginale eksterne kostnader ved havnedrift: Report No. 1590," *Transportøkonomisk institutt (TØI), Oslo, available at: www. toi. no/getfile. php* (2017).
[15] Bergen Havn, "The freight port - Regional freight hub," updated n.d., n.d., accessed 09.11, 2025, https://www.bergenhavn.no/en/docks/freight-harbor.
[16] Informant LS21(2023).
[17] Informant EU8 (2022).

Stavanger, and Bergen – are all in strategic locations to expand future trade relations with large ports in other countries bordering the North Sea.

3.2 Port infrastructure and facilities

Another key factor impacting port efficiency is the size of the port and its terminal capacity. This can be measured via data on port infrastructure, such as the total length and number of berths/quays; water depth/draft, which will determine the maximum size of vessels able to dock at the port; available port space and backup space on terminals; port shelter; and the distance from port terminals to breakwater heads.[18] Other critical information includes available terminal equipment (e.g., cranes) for loading and unloading of different types of cargo, and overall freight handling capacity, including infrastructure for cargo transshipment. Maritime stakeholders also emphasize the availability of storage facilities at ports, bunkering infrastructure, onshore power supply (OPS), and intermodal infrastructure (i.e., connections to road and rail networks). Intermodal facilities play a crucial role in efficient cargo flow because intermodal transport is typically associated with higher flexibility, lower costs, and less pollution.

Northern Norway commonly lacks facilities for transferring goods from sea to rail. For example, the Port of Helgeland currently lacks an efficient way to get freight onto the Nordland Railway.[19] However, our informants highlighted several ongoing projects to strengthen port infrastructure. The Port of Narvik is dredging and deepening its waterways and constructing a new deepwater quay and several new terminals, including an intermodal terminal.[20] The Port of Bodø is planning new terminal infrastructure to support a new shipping corridor between Bodø and Tromsø, with some port stops along the way.[21] The port of Harstad is focusing on Rødskjær,[22] while the Port of Tromsø is working on improving port infrastructure on Breivika.[23] Both the Port of Kirkenes and the Port of Åndenes continue to explore a possible connection to the Northern Sea Route and development of transshipment ports.[24]

3.3 Port services

Basic port services include assisting vessels docking at a port, providing pilotage, towing, berthing, mooring, and tug assistance for larger ships. The frequency with which these

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[18] Oliwia Pietrzak et al., "Improving seaport competitiveness by creating a connection to the national rail network," *Transport Problems* 15 (2020).
[19] Informant PA22 (2023).
[20] Narvik Havn, *Strategisk plan for Narvik Havn 2022-2025* (2022), https://www.narvikhavn.no/wp-content/uploads/2023/01/Strategisk-plan-for-Narvik-Havn-KF-2022-2025.pdf.; Informant PA7 (2022).
[21] Tromsø Havn, "Tromsø, Harstad og Bodø sammen om ny, grønn godskorridor," updated 24.06.2024, 2024, accessed 09.11, 2025, https://tromso.havn.no/tromso-harstad-og-bodo-sammen-om-ny-gronn-godskorridor/; Bodø Havn, "Bodø Havn KF - ny terminal - Del 1 – Tilbudsinvitasjon. Notice ID: 2025-110293," doffin.no, updated 30.06.2025, 2025, accessed 09.11, 2025, https://www.doffin.no/notices/2025-110293.
[22] Harstad Havn, "Rødskjær over enda ett hinder på vei mot realisering," updated 03.05.2023, 2021, accessed 09.11, 2025, https://harstadhavn.no/rodskjaer-over-enda-ett-hinder-pa-vei-mot-realisering/.
[23] Tromsø Havn, "Utarbeider strategisk plan for utvikling av søndre del av Breivika havneområde," updated 03.06.2024, 2024, accessed 09.11, 2025, https://tromso.havn.no/utarbeider-strategisk-plan-for-utvikling-av-sondre-del-av-breivika-havneomrade/.
[24] Informant PA14 (2023); Informant PA19 (2023).

services are used can be estimated based on the number of port calls registered at a port throughout the year. Another basic service is cargo handling (stevedoring) and loading or unloading of different types of cargo onboard ships, measured as the total throughput per cargo type at the port. Additional port services often include temporary storage and warehousing; ship repair and maintenance services; customs clearance (for international trade); port security/control system services; environmental control; bunkering and OPS services; freshwater supplies; and waste disposal.

Basic services are similar at most ports; for a port to become an attractive choice compared to other surrounding ports, it needs to provide greater cargo handling capacity and more efficient basic services at a reduced unit cost. Another approach is for the port to promote additional value-added services (VAS) for specific products that brings added value to the logistics chain, benefiting customers while increasing the competitiveness of the port and its strategic advantage.[25] The providers of such added services, who are typically third-party logistics providers, benefit by gaining a competitive advantage by offering unique services. Such services can include product technical support and quality control; inventory management; tracking and tracing; partial assembly; packaging and labelling; warehousing and minor product customization; local transportation; and reverse logistics services (i.e., return of products for resale, repair, or disposal). The providers of these varied services represent the largest group of port stakeholders.

3.4 Port efficiency

Existing literature highlights the potential of ports to improve their performance by eliminating technical inefficiencies and exploiting economies of scale. High-quality ports attract more customers, resulting in a strong correlation between throughput and service quality. This includes the efficiency and speed of cargo-handling operations (throughput per hour), and therefore the time ships spend at berth[26] (i.e., the number of containers or tons of cargo moved per working hour per ship). Time spent in port, in turn, influences carriers' operating costs.[27] Streamlining cargo-handling services can generate benefits throughout supply chains, measured in hours and days saved. Ports should also provide flexibility in cargo handling services when needed, to reduce waiting time, thereby reducing the cost of inventory in transit for cargo owners. High performance ports have built-in preparedness and contingency plans to minimize risk and disruptions to port operations.

Efficient use of port infrastructure is also essential. This efficiency can be expressed as cargo volume per quay (usage factor) in tonnes/metre. Larger ports receive larger volumes of cargo and operate dedicated terminals and facilities for certain cargo types (e.g. containers) and shipping operations (e.g., transshipment). Port efficiency is dependent on uninterrupted cargo flow; therefore, operational efficiency will suffer if connectivity is poor. It is important that onshore and offshore operations are well integrated to optimize efficiency. The

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[25] Lu Chen and Theo Notteboom, "Determinants for assigning value-added logistics services to logistics centers within a supply chain configuration," *Journal of International Logistics and Trade* 10, no. 1 (2012).
[26] Kenneth Løvold Rødseth et al., "Port efficiency and emissions from ships at berth: application to the Norwegian port sector," *Maritime economics & logistics* 22, no. 4 (2020).
[27] Tongzon, "Port choice and freight forwarders"; Ricardo J Sánchez et al., "Port efficiency and international trade: port efficiency as a determinant of maritime transport costs," *Maritime economics & logistics* 5, no. 2 (2003).

competitiveness of a port is not solely dependent upon how it compares to neighbouring ports; in fact, a port's main competitors are often land-based transport alternatives. Key factors increasing port efficiency and thus making a port more attractive compared to these competitors, include modern infrastructure, advanced technologies,[28] a skilled and motivated workforce, streamlined and supportive government policies,[29] optimized operational procedures,[30] and innovative solutions to persistent challenges (including quick responses to port users' needs).[31]

3.5 Port fees and cargo handling charges

From shipping companies' point of view, the key costs at ports are the port fees and charges for cargo handling services, along with time costs related to the cargo (e.g., storage) and the vessels (e.g., personnel costs, time spend in port), which in turn is dependent on factors like frequency of services, efficiency in cargo handling, capacity, and ability to accommodate larger vessels; these factors generally favour economies of scale.[32] In addition, port users must consider the cost of inland freight transportation via road, rail, or inland waterways to final destinations. There can be considerable differences in costs between ports, mainly based on whether the terminal operation is under public, private, or mixed ownership. Publicly owned ports tend to be more expensive to use, due to the collective bargaining agreements in force with their workers.[33] In addition to the general factors discussed above, volume discounts, priority handling, and the negotiating power of shippers can also significantly impact port fees and cargo handling charges.[34]

Lower port charges often attract more carriers as they contribute to reducing operating costs. These port charges quickly add up as sailing distances get shorter and the carriers regularly call at more ports, contributing to a larger portion of the total ship transportation cost. This can make shipping operations unprofitable and result in a need for government subsidies, particularly during periods of low shipping demand (freight rates).

3.6 Port security

Maritime security has become a paramount international concern since the tragic events of September 11, 2001. Seaports which handle substantial volumes of cargo remain vulnerable to terrorist threats, and various initiatives have been implemented to mitigate these risks and enhance port security. International societies have adopted key port security regulations, including the International Ship and Port Facility Code (ISPS Code), Container Security Initiative (CSI), Customs-Trade Partnership Against Terrorism (C-TPAT), 24-Hour Advanced Rule, and Authorized Economic Operator (AEO) programme. These regulations aim to reduce the likelihood and impact of port-related terrorism.

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[28] Fernando Almeida, "Challenges in the digital transformation of ports," *Businesses* 3, no. 4 (2023).
[29] Rudy Eruwan Jamain, Roza Hazli Zakaria, and Nurulhuda Mohd Satar, "The effect of regulations on port efficiency: an empirical study using regulatory quality and control of corruption index," *Social and Management Research Journal (SMRJ)* 20, no. 1 (2023).
[30] Paola Alzate et al.,"Operational efficiency and sustainability in smart ports: a comprehensive review," *Marine Systems & Ocean Technology* 19, no. 1 (2024).
[31] Informant PA16 (2023).
[32] Svindland, Monios, and Hjelle, "Port rationalization and the evolution of regional port systems: the case of Norway."
[33] Svindland, Monios, and Hjelle, see note 32.
[34] Yisong Lin and Xuefeng Wang, "Port selection based on customer questionnaire: a case study of German port selection," *European Transport Research Review* 11, no. 1 (2019).

Robust security measures are essential for the smooth flow of goods and the minimization of disruptions to global supply chains. They also attract investment and stimulate economic growth in port cities and their surrounding regions. However, it is essential to strike a balance between security and efficiency. While a certain level of security measures can enhance port efficiency, excessive regulations may have adverse effects.[35] Three key challenges in port security can be highlighted: a) developing realistic threat scenarios; b) accurately estimating the likelihood of such threats; and c) assessing the potential non-local economic impacts of security measures.[36]

3.7 Port connectivity

The importance of a port largely depends on how well it is connected to larger transportation networks.[37] Connectivity is one of the key criteria in determining a port's competitiveness and future growth prospects. Of particular importance is the port's proximity to major (global) trade route(s) and access to large regional transshipment hubs via frequent services along well-established feeder routes. Equally important are transport connections to the hinterland via roads, railways, and inland waterways, connecting the port to nearby cities and industrial zones.[38] Despite the sustained growth of port throughput worldwide over the last several decades, and large investments in the reform and modernization of infrastructure, hinterland transport has not kept pace with productivity increases in maritime transportation, leading to bottlenecks and transport barriers.[39] For many ports, the weakest link in their transportation chains is hinterland access, due to congested roads and inadequate or non-existent rail connections, causing delays and increased transport costs.

Good port-hinterland connectivity is essential for the efficiency of the whole intermodal transport chain. Changes in port-hinterland relations have a clear impact on port development patterns. Ports in need of additional space for their onshore activities are increasingly looking to the hinterland for available land for the construction of inland intermodal terminals[40] (or "dry ports"), which then need to be connected to the port by rail, road, or inland waterways. These dry ports are usually developed close to railway and road junctions to facilitate the transfer of containers between modes of transport. Alongside the environmental and quality-of-life benefits of shifting freight from road to rail, dry port concepts provide several advantages for seaports:1) Dry ports allow seaports to tap into new markets in their hinterlands, increasing their reach and cargo throughput; 2) dry ports enable seaports to increase their capacity without requiring significant investments in additional port infrastructure; 3) dry ports can offer a range of services, such as customs clearance, warehousing, and value-added services, improving the overall experience for shippers and

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[35] Gi-Tae Yeo, Ji-Yeong Pak, and Zaili Yang, "Analysis of dynamic effects on seaports adopting port security policy," *Transportation Research part A: Policy and practice* 49 (2013).
[36] Michael R Greenberg, "Risk analysis and port security: some contextual observations and considerations," *Annals of Operations Research* 187, no. 1 (2011).
[37] Haiying Jia et al., "Norwegian port connectivity and its policy implications," *Maritime Policy & Management* 44, no. 8 (2017).
[38] Pietrzak et al., "Improving seaport competitiveness by creating a connection to the national rail network."
[39] Behzad Behdani et al., "Port-hinterland transport and logistics: emerging trends and frontier research," *Maritime Economics & Logistics* 22, no. 1 (2020).
[40] Erica Varese, Danilo Stefano Marigo, and Maria Rosaria Lombardi, "Dry Port: A Review on Concept, Classification, Functionalities and Technological Processes," *Logistics* 4, no. 4 (2020).

transport operators; and 4) by diverting freight traffic from congested urban areas, dry ports reduce traffic congestion and demand for additional infrastructure investments.[41]

3.8 Port development potential

The ever-changing nature of global economic development means that ports must continually adapt and develop new strategies for gaining a competitive advantage. One such strategy is to strive to provide basic services at a lower cost than other nearby ports. Another is to provide specialized services, including value-added services, which other ports do not provide. This might include services geared towards a particular cargo type or a niche market. Regardless of the strategies they choose, ports need to have a strong focus on customer needs and be customer-driven[42] to ensure long-term success. Ports which maintain a consumer-driven approach are ultimately those who will succeed in the long term. Identifying customer needs and being willing to adapt to changing conditions is vital and requires port management to continuously reassess their strategies. Large customers have substantial bargaining power over smaller ports because of the amount of business they can choose to bring in or take elsewhere.

There are other factors that can impact on the future growth of ports. Profitability generally requires ports to handle large numbers of port calls annually and maintain continuous flow of cargo. Large number of ports located in Northern Norway rely on the transport of natural resources (including wild-caught cod, farm-raised salmon, fossil fuels, minerals, ore, and metals) and industrial products processed from those resources (e.g., seafood, steel, cement, fertilizers). Some of these commodities show large fluctuations in both price and availability on global commodity markets, impacting throughput at ports and profitability.

Governments worldwide are increasingly adopting inclusive growth strategies, aiming to balance economic growth with social benefits. Corporations are also embracing this trend, seeking to minimize negative impacts and maximize positive contributions. In this context, port development has recently gained attention as a significant driver of sustainable development. In March 2018, several large ports signed the World Ports Sustainability Program declaration,[43] committing to contribute to the UN Sustainable Development Goals (SDGs). Additionally, many national port development plans now incorporate social and environmental standards alongside economic objectives. The energy transition from fossil fuels to low-or-zero-emission energy alternatives presents challenges for ports which are now required to supply both onshore electrical power and alternative fuels to both ships and onshore transport. Several seaports in Norway have already installed systems to offer onshore power (OPS) to ships at berth. Some ports have also implemented the Environmental Port Index (EPI) scheme, which tracks the types of fuel used by ships while docked and applies penalties or discounts based on their pollution levels. This approach combines both reward and penalty systems to promote sustainable port operations.

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[41] Violeta Roso, Johan Woxenius, and Kenth Lumsden, "The dry port concept: connecting container seaports with the hinterland," *Journal of Transport Geography* 17, no. 5 (2009).
[42] Theo E Notteboom and Willy Winkelmans, "Structural changes in logistics: how will port authorities face the challenge?," *Maritime Policy & Management* 28, no. 1 (2001).
[43] WPSP, "World Ports Sustainability Program (WPSP) Charter," 14.03 2018, https://sustainableworldports.org/wp-content/uploads/wpsp-declaration.pdf.

Other issues impacting future development of ports include the size of the local population (and thus the local market for goods and services); this can impact consumer demand and labour dynamics such as the availability of skilled workers. As discussed above, land availability for further development in the vicinity of the ports may be limited by local populations, as many ports are close to city centers, preventing further port expansion; ports may also occupy large land areas suited for urban development, creating competition even for their existing land. This can lead to the relocation of ports, as seen in the case of the Port of Bergen.[44] Finally, national and local government policies and regulations have significant impacts on port development, as can the marketing efforts and development plans of local port authorities.

3.9 Port governance

Ports can be held in public, private, or mixed ownership,[45] and their ownership and governance structures are important determinants of their performance.[46] Analyses of the governance of ports has mostly been limited to the central role of public port authorities, but the role of private firms in port governance is significant, both as service providers and as owners of some facilities and infrastructure. The sector has seen a shift from a focus on government ownership and management to the provision of private services in a competitive environment.[47] As ports are increasingly privatized, they are oriented towards profit maximization, through strategies must be tailored to the characteristics and economic activities in each port. Port authorities are increasingly fulfilling a role akin to development companies[48] or stakeholder managers in the supply chain.[49] This central position of port authorities in management processes presents a potential argument for retaining a level of state involvement. This role has also seen port authorities extending their influence from the ports themselves to the hinterland to address supply chain bottlenecks and promote regional development.

3.10 Environmental and social impacts of port activity

Ports facilitate domestic and international cargo flow, but they can also be significant sources of environmental pollution in coastal and urban areas. Ships and cargo handling equipment release atmospheric pollutants, while accidental spills, leaks, and runoff from port facilities can contaminate water bodies and soil. Additionally, noise pollution from cargo handling and ship traffic can adversely impact nearby communities. Furthermore, port operations generate

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[44] Remco Elric de Koning, Hans Jacob Roald, and Akkelies van Nes, "A scientific approach to the densification debate in Bergen centre in Norway," *Sustainability* 12, no. 21 (2020).
[45] Sigrid Damman and Markus Steen, "A socio-technical perspective on the scope for ports to enable energy transition," *Transportation Research Part D: Transport and Environment* 91 (2021).
[46] Peter W. de Langen, "Governance in Seaport Clusters," in *Port Management, Seminal papers from Maritime Economics and Logistics, Palgrave Readers in Economics*, ed. Hercules E. Haralambides (Springer, 2015).
[47] Larissa M van der Lugt, Peter W de Langen, and Lorike Hagdorn, "Strategic beliefs of port authorities," *Transport reviews* 37, no. 4 (2017).
[48] van der Lugt, de Langen, and Hagdorn, "Strategic beliefs of port authorities"; Rickard Bergqvist and Jason Monios, *Green ports: inland and seaside sustainable transportation strategies* (Elsevier, 2018).
[49] Behdani et al., "Port-hinterland transport and logistics: emerging trends and frontier research."

various types of waste, including solid waste, hazardous waste, and sediment from dredging,[50] which can contribute to further environmental degradation if not managed properly.[51]

Traditionally, ports and cities have been closely intertwined. However, the relationship between port and city growth has weakened over time. While well-functioning ports offer numerous economic benefits, such as lower trade costs, increased value-added activities, and job creation, these benefits often spill over to other regions. Less than 5% of economic links between ports and suppliers occur within the port or its immediate area. The majority of these links are concentrated in the country's main economic centre, which may be located a significant distance from the port. In contrast, negative impacts like waterfront and urban congestion, health risks,[52] and labour issues[53] are often concentrated within the port city itself. As seaports continue to expand, these challenges become increasingly pronounced.

4. The Seaport System in Norway

4.1 Governance, ownership, and infrastructure

The Norwegian government has classified 32 seaports within Norway as national network ports, nine of which are located in Northern Norway (*Figure 1*). National network ports have one or more terminals connected to the main national transport network providing good logistics services and transport solutions for local communities and industries for both domestic and international freight and passenger transport.[54] National network ports are primarily owned by the local municipalities, with the majority of port infrastructure located in cities and larger towns, with several additional terminals (many owned by private companies) in nearby locations. The municipalities have significant freedom to choose how to organize their port activities; in some cases, ports are structured as integral components of the municipal administration, while in others, they are operated by limited companies with less opportunity for political influence. There are no state-owned commercially driven ports in Norway. The Norwegian government takes responsibility for ensuring that national network ports have adequate connections to onshore transport.

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[50] Ashley Carse and Joshua A Lewis, "Toward a political ecology of infrastructure standards: Or, how to think about ships, waterways, sediment, and communities together," *Environment and Planning A: Economy and Space* 49, no. 1 (2017).
[51] Hosein Saeedi Pash et al., "Analysis of most important indices in environmental impacts assessment of ports," *Civil Engineering Journal* 3, no. 10 (2017); Martí Puig, Chris Wooldridge, and Rosa Mari Darbra, "Identification and selection of environmental performance indicators for sustainable port development," *Marine pollution bulletin* 81, no. 1 (2014).
[52] Olaf Merk, "The competitiveness of global port-cities: synthesis report," (2013).
[53] Edna Bonacich and Jake B Wilson, *Getting the goods: Ports, labor, and the logistics revolution* (Cornell University Press, 2011).
[54] Avinor et al., Nasjonal transportplan 2014-2023, (vegvesen.no, 2012); Samferdselsdepartementet, Nasjonal transportplan 2018–2029, (2016).

Of the 32 national network ports, 25 provide road or rail connections, while the remaining 7 ports are port-to-port-terminals. The national government has designated the ports of Oslo, Kristiansand, Stavanger, Bergen, and Tromsø as particularly important for the development of the Norwegian maritime transportation system. Norway has 317 registered ISPS ports[55] and a total of 1,253 ISPS registered quays (of which 807 are private and 440 public). Northern Norway has 74 ISPS ports. The number of state-run fishing ports is 767 (340 in Northern Norway) and ports for leisure/boating activities are estimated to number about 1,500. In total, Norway has more than 3,500 registered quays and maritime points of access. A total of 256 ports[56] provide 166 ferry connections for passengers and limited cargo.

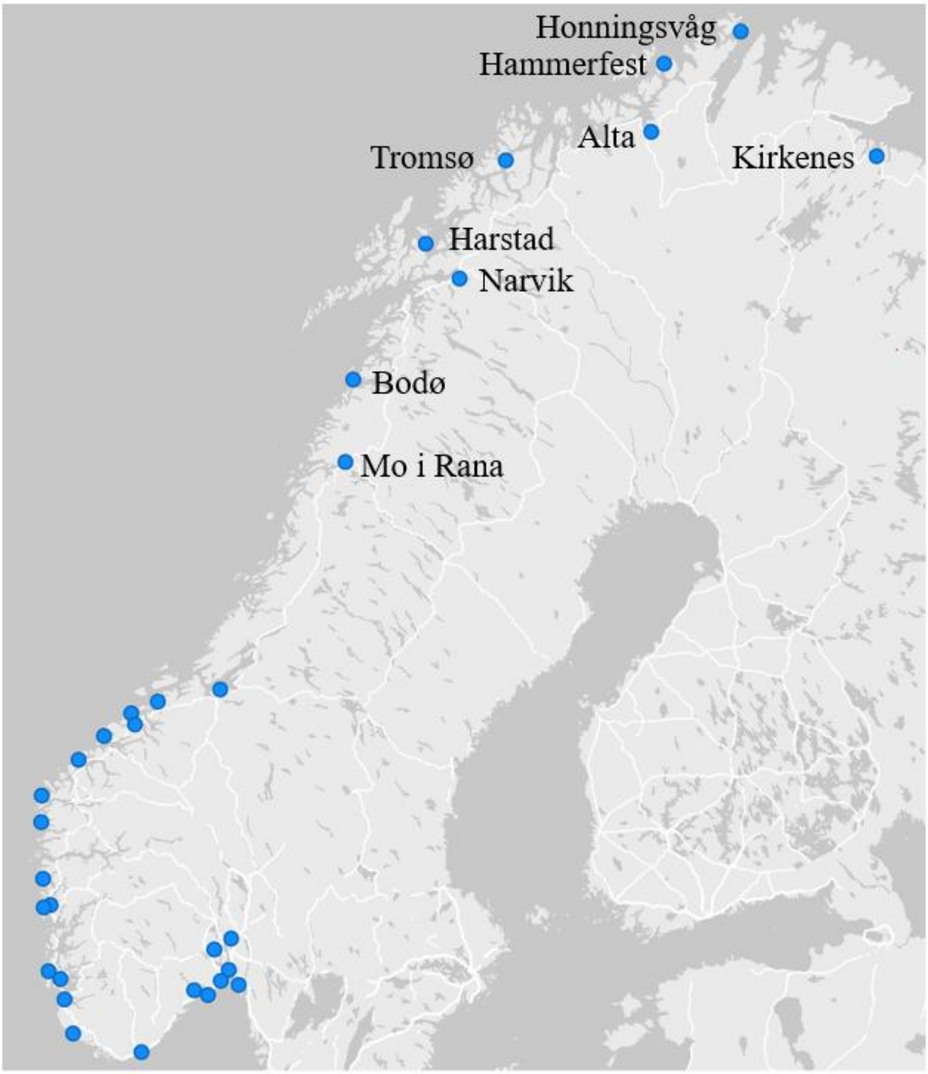

Figure 1: Location of the 32 national network ports in Norway.

[55] The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention (1974/1988) on Maritime security including minimum security arrangements for ships, ports and government agencies. It came into force in 2004, and prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to detect security threats and take preventive measures against security incidents affecting ships or port facilities used in international trade.
[56] Kystverket, "Kart," (Kystverket, 2025). https://kart.kystverket.no/.

4.2. The role of ports in the national economy

Seaports are not merely nodes of transfer between sea and land; they are the arteries of the national economy and the guarantors of sovereignty. The Norwegian port infrastructure fulfils a set of critical functions: First, ports act as the primary interface for supply chain security and national preparedness. It is crucial that Norwegian ports have the ability to receive allied reinforcements and maintain the flow of essential goods in times of crisis. Second, ports are essential to a green transition in the logistics sector. They are evolving into energy hubs, providing onshore electrical power, hydrogen and ammonia bunkering, and infrastructure for battery charging. Thirdly, ports are important for regional value creation. They serve as gateways to global markets for Norway's export-oriented industries. The efficiency of a port directly impacts the competitiveness of industries in the nearby hinterland.

4.3 Cargo composition and major commodities

Seaports can be categorized by the type of cargo they mainly handle (*Table 3-5*). Norwegian ports handled a total of 215.2 million tonnes of cargo in 2023. Of this, dry bulk accounted for 98.4 million tonnes (46%), liquid bulk 93.4 million tonnes (43%), general cargo 14.7 million tonnes (6%), and container cargo 8.6 million tonnes (4%).

Large quantities of liquid bulk (e.g., petroleum products and LNG) and dry bulk cargo (ores, industrial minerals, construction materials, metals) are shipped from selected Norwegian ports to international markets. The largest ports specializing in liquid bulk are in Bergen (Omland), Haugesund (Karmsund), Tønsberg, Hammerfest, and Grenland (Porsgrunn), while the main dry bulk ports are in Narvik, Grenland (Porsgrunn), Bremanger, Mo I Rana, and Trondheim. Several other ports handle large quantities of both liquid and dry bulk, including Haugesund (Karmsund), Kristiansund, Molde, and Oslo. Several ports serve multiple purposes, handling roughly equal shares of several cargo types including general cargo and containers. These include the Ports of Oslo, Kristiansand, Ålesund, Stavanger, Tromsø, Måløy, and Bodø.

While the majority of liquid and dry bulk cargo exported from Norway is shipped via ports on the northern and western coasts, the Port of Oslo (Sjursøya-Ormsund terminals) and other ports in the Oslo region handle most of the container cargo arriving in Norway from major European container hubs (e.g., Rotterdam). This is primarily because most of this cargo is bound for the Oslo metropolitan area and surrounding regions, which constitute the largest population centre and consumer market in Norway. This provides economies of scale and keeps transport and distribution costs lower. From the Oslo region, containerized cargo bound for other regions of Norway is redistributed by land-based modes (trucks, railway) rather than being transported further by sea. This includes land-based transport to both Western and Northern Norway.[57] However, discussion is already taking place about the possibility for a regional feeder hub on the west coast of Norway, in Stavanger or Bergen, that could serve the whole western and northern coasts.[58]

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[57] Some cargo is transported directly to Kristiansand in the south and to both Stavanger and Bergen on the west coast, but in much lower volume than to Oslo.
[58] Svindland, Monios, and Hjelle, "Port rationalization and the evolution of regional port systems: the case of Norway."

Though only a small portion of the container cargo arriving from European hubs is currently transported by ships directly to ports outside the Oslo region, this is likely to increase with increased population growth and industrial activities in Western and Northern Norway.

The Norwegian government's current policy objective is to further increase maritime transportation of goods where possible.[59] This would require shipping containers and general cargo directly from European hubs to ports in Western and Northern Norway, instead of relying on long-haul transport by trailer trucks or railways from the Oslo region.[60] Some shipping companies are already offering container services to select feeder ports in Western and Northern Norway, typically on a weekly basis using 700-900 TEU container vessels.[61] Transshipment of containers at sea to smaller container/general cargo vessels has also been proposed.[62] Inter-regional distribution of cargo to several smaller ports could be done by battery-electric or hybrid vessels to reduce emissions.[63]

Table 3: Ranking of Norwegian liquid and dry bulk ports by throughput in tonnes in 2023. Source: SSB 10916

No.	Port	Liquid bulk throughput in tonnes
1	Bergen and Omland	63,722,637
2	Haugesund (Karmsund)	4,944,815
3	Tønsberg	4,712,845
4	Hammerfest	4,676,610
5	Grenland (Porsgrunn)	3,655,507
6	Oslo	1,696,559
7	Molde	1,608,643
8	Kristiansund	1,478,220
9	Borg (Fredrikstad)	723,899
10	Ålesund	523,452
11	Trondheim	518,276
12	Kristiansand	496,386
13	Helgeland	451,267
14	Brekstad (Ørland)	402,429
15	Stavanger	327,647

No.	Port	Dry bulk throughput in tonnes
1	Narvik	21,336,587
2	Grenland (Porsgrunn)	6,491,764
3	Bremanger (Svelgen)	4,497,372
4	Mo i Rana	2,869,962
5	Trondheim	2,164,708
6	Kristiansund	1,896,593
7	Haugesund (Karmsund)	1,767,601
8	Bergen and Omland	1,561,506
9	Kristiansand	1,514,793
10	Molde	1,477,893
11	Borg (Fredrikstad)	1,477,847
12	Oslo	1,405,589
13	Stavanger	1,297,060
14	Brønnøy	1,252,767
15	Salten (Sørfold)	1,201,000

[59] Regjeringen, "Retningslinjer for tilskudd til nærskipsfart (insentivordningen)," ed. Samferdselsdepartementet and Nærings- og fiskeridepartementet (2022). https://www.kystverket.no/globalassets/sjotransport-og-havn/tilskuddsordninger/narskipsfart/reviderte-retningslinjer-02032022.pdf.

[60] Kenneth Løvold Rødseth, Paal Brevik Wangsness, and Halvor Schøyen, "How do economies of density in container handling operations affect ships' time and emissions in port? Evidence from Norwegian container terminals," *Transportation Research Part D: Transport and Environment* 59 (2018).

[61] Msakni et al., "Analyzing different designs of liner shipping feeder networks: A case study."

[62] Magnus Bolstad Holm et al., "Shortsea liner network design with transshipments at sea: a case study from Western Norway," *Flexible Services and Manufacturing Journal* 31, no. 3 (2019).

[63] Ormevik, Erikstad, and Fagerholt, "Evaluating port development strategies for a modal shift: a Norwegian case study."

No.	Port	Liquid bulk throughput in tonnes
16	Tromsø	326,355
17	Harstad	272,032
18	Florø	265,620
19	Drammen	198,527
20	Bodø	119,578

No.	Port	Dry bulk throughput in tonnes
16	Sauda	1,181,413
17	Kragerø	1,078,740
18	Drammen	1,055,103
19	Brekstad (Ørland)	1,022,216
20	Nesna	890,800

Table 4: Ranking of Norwegian general cargo ports by throughput in tonnes in 2023. Source: SSB 10916

No.	Port	General cargo RoRo self-propelled	General cargo RoRo not self-propelled	Other general cargo (break-bulk)	TOTAL
1	Mo i Rana	0	0	1,333,533	1,333,533
2	Kristiansund	128	404,655	887,807	1,292,590
3	Drammen	209,222	0	837,811	1,047,033
4	Larvik	586,830	88,329	160,084	835,243
5	Oslo	261,858	225,551	248,999	736,408
6	Trondheim	10,702	4,743	693,502	708,947
7	Haugesund (Karmsund)	2,191	342,119	325,298	669,608
8	Stavanger	83,991	257,532	313.234	654,757
9	Bergen and Omland	29,795	62,612	494,107	586,514
10	Kristiansand	443,441	57,312	85,338	586,091
11	Grenland (Porsgrunn)	7,510	180,052	290,118	477,680
12	Borg (Fredrikstad)	13,169	60,674	335,427	409,270
13	Myre-Øksnes	0	0	355,403	355,403
14	Ålesund	1,696	71	295,177	296,944
15	Florø	0	0	226,513	226,513
16	Helgeland	60	0	194,103	194,163
17	Tromsø	52	46	188,466	188,564
18	Brekstad (Ørland)	0	14,719	129,179	144,142
19	Alta	345	0	122,423	122,768
20	Hammerfest	5	10	108,279	108,294

Table 5: Ranking of Norwegian container ports by throughput in tonnes in 2023. Source: SSB 10916

No.	Port	Containers LoLo	Containers RoRo	TOTAL
1	Oslo	1,393,328	32,519	1,425,847
2	Grenland (Porsgrunn)	1,110,228	42,826	1,153054
3	Stavanger	883,714	134	883,848
4	Ålesund	482,997	975	483,972
5	Hadsel (Stokmarknes)	455,839	0	455,839
6	Borg (Fredrikstad)	454,639	0	454,639
7	Larvik	410,639	4	410,643
8	Haugesund (Karmsund)	322,201	85,773	407,974
9	Kristiansand	406,958	24	406,982
10	Moss	342,037	59,138	401,175
11	Helgeland	388,958	0	388,958
12	Kristiansund	293,878	0	293,878
13	Bergen and Omland	187,265	18,670	205,935
14	Florø	191,768	0	191,768
15	Trondheim	157,085	19,536	176,621
16	Måløy (Nordfjord)	102,108	0	102,108
17	Salten (Sørfold)	93,954	0	93,954
18	Mo i Rana	78,175	0	78,175
19	Bremanger (Svelgen)	60,205	0	60,205
20	Egersund	56,413	0	56,413

5. Seaports in Northern Norway

5.1 The importance of seaports

Seaports are indispensable assets for Northern Norway, exerting a profound influence on the region’s economic vitality (*Figure 2*). As essential trade gateways, these ports facilitate the import and export of a wide range of goods, connecting Northern Norway to both domestic and international markets. Their role is particularly critical given the region’s vast distances, dispersed communities, and challenging terrain, which render maritime transport a vital lifeline for commerce and connectivity.

Seaports are also pivotal in supporting Northern Norway’s key industries, which are foundational to the region’s economy. The fishing industry, a cornerstone of coastal communities, relies heavily on ports for landing catches, processing seafood, and distributing products. The region's robust oil and gas sector utilizes ports as crucial logistical hubs for offshore operations, supply vessels, and the export of oil and gas products. Industries such as mineral processing depend on seaports for the export of finished goods, while the mining industry relies on seaports for the export of ore concentrates, industrial minerals, and construction materials. This mining and metal processing activity has significant implications for the region's economy, infrastructure development, and logistical networks.

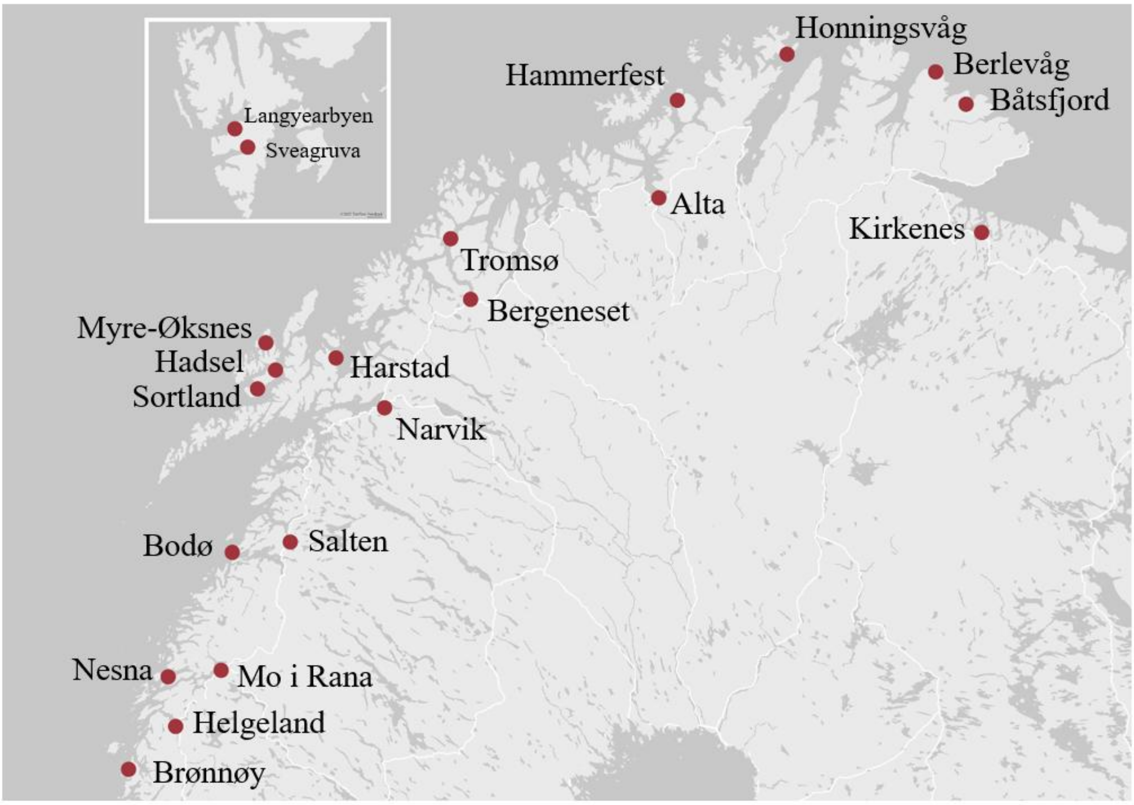

Figure 2: The 21 selected seaports in Northern Norway and Svalbard analysed in this study.

Northern seaports also hold strategic importance, especially during a time of increased geopolitical tension. The Northern Sea Route, which is becoming more accessible because of climate change, means that seaports are becoming more important for international trade. Furthermore, industrial parks located at or near several of the seaports in Northern Norway play a crucial role in regional economic development, providing infrastructure, services, and collaboration opportunities for local businesses. The largest is Mo Industrial Park, with 110 companies and 2,900 jobs.[64] Others include Glomfjord Industrial Park,[65] Helgeland Base (Sandnessjøen),[66] and NorSea Polarbase (Hammerfest).[67] Additional industrial parks are currently under development, including Hålogaland Business Park (Lødingen/Narvik),[68]

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[64] MIP, "Mo Industrial Park ", updated n.d., n.d., accessed 09.11, 2025, https://www.mip.no/en/.
[65] GIP, "Glomfjord Industripark ", updated n.d., n.d., accessed 09.11, 2025, https://www.gip.no/.
[66] CCB, "Velkommen til Helgelandbase ", updated 22.09.2025, 2025, accessed 09.11, 2025, https://ccb.no/vare-selskaper/helgelandsbase/.
[67] Norseagroup, "NorSea Polarbase AS," updated n.d., n.d., accessed 09.11, 2025, https://norseagroup.com/en/baser/norsea-polarbase-as.
[68] Narvikhavn, "Hålogaland Business park," updated 23.02.2023, 2023, accessed 09.11, 2025, https://www.narvikhavn.no/en/eiendom-og-areal/land-planning/halogaland-naeringspark/.

Helgeland Industrial Park (Møsjoen), Nesna Industrial Park (Nesna),[69] and Grøtsund Industrial Park (Tromsø).[70]

5.2 Seaports by cargo type

Dry bulk cargo is the most common cargo type handled by seaports in Northern Norway in 2023 (31.28 million tonnes; *Table 6*). The Port of Narvik shipped 21.3 million tons of dry bulk, accounting for 68% of dry bulk cargo handled by the 21 selected seaports in Northern Norway in 2023 (and 22% of all bulk cargo handled by ports in Norway). Most of this cargo was iron ore from the Kiruna mine in Northern Sweden, brought to the Port of Narvik via the Ofoten/Ore Railway. Excluding this Swedish iron ore, the remaining dry bulk cargo handled by the selected ports in Northern Norway totalled 9.94 million tonnes in 2023. The Port of Mo i Rana handled 29.0% of this (2.87 million tonnes), Brønnøy 12.6% (1.25 million tonnes), Salten (Sørfold) 12.1% (1.20 million tonnes), Nesna 9.0% (0.89 million tonnes), Sortland 6.4% (0.63 million tonnes), Bergneset 5.8% (0.58 million tonnes), and Helgeland 5.3% (0.53 million tonnes).

Liquid bulk cargo is the second most common cargo type handled by seaports in Northern Norway in 2023 (totalling 6.4 million tonnes; *Table 6*). The Port of Hammerfest shipped 4.68 million tonnes, accounting for 73.5% of all liquid bulk cargo handled by the 21 selected seaports in Northern Norway (and 5.0% of all liquid bulk cargo handled by ports in Norway). Other ports shipping large quantities of liquid bulk cargo in 2023 were Helgeland 7.1% (0.45 million tonnes), Tromsø 5.1% (0.33 million tonnes), and Harstad 4.3% (0.27 million tonnes).

The ports handling the greatest volumes of general cargo in Northern Norway in 2023 (a total of 2.54 million tonnes; *Table 6*) are Mo I Rana, accounting for 52.5% (1,333,533 tons) of the total, followed by Myre-Øksnes at 14.0% (355,403 tons), Helgeland 7.6% (194,163 tonnes), Tromsø 7.4% (188,564 tonnes), Alta 4.8% (122,768 tonnes), and Hammerfest 4.3% (108,294 tonnes).

The volume of containerized cargo handled by the selected seaports in Northern Norway is low in comparison (1.11 million tonnes in 2023; *Table 6*). The Port of Hadsel accounted for the largest share of this with 41.1% of the total (455,839 tonnes), followed by Helgeland 35.1% (388,958 tonnes), Salten (Sørfold) 8.5% (93,954 tonnes), Mo i Rana 7.05% (78,175 tonnes), and Sortland 4.3% (47,224 tonnes).

Of the total cargo handled by the seaports in Northern Norway in 2023, dry bulk cargo was 75.7%, liquid bulk cargo 15.5%, general cargo 6.1%, and containerized cargo 2.7%. If the transit cargo of iron ore from Kiruna in Sweden is excluded, then the percentages are 50% dry bulk cargo, 32% liquid bulk cargo, 12.7% general cargo, and 5.5% containerized cargo. These proportions are similar to those for the whole of Norway.

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69 Rana Utvikling, "Nesna Industrial Park," ru.no, updated n.d., 2021, accessed 09.11, 2025, https://ru.no/en/what-we-do/our-strategic-projects/nesna-industrial-park/.
70 TromsøHavn, "Grøtsund industrihavn," updated 11.07.2025, 2021, accessed 09.11, 2025, https://tromso.havn.no/tjenester/grotsund-havne-og-industriomrade/.

Table 6: Cargo throughput in tonnes by type at the selected ports in Northern Norway in 2023. Source: SSB 10916

Key port	Dry bulk	Liquid bulk	Container	General cargo	TOTAL
Longyearbyen	94,144	12,954	19,869	2,222	129,189
Sveagruva	60,034	0	0	0	60,034
Kirkenes	5,109	36,189	0	12,913	54,211
Båtsfjord	10,021	2,984	0	79,188	92,193
Berlevåg	0	368	0	516	884
Honningsvåg	0	0	0	3,000	3,000
Hammerfest	190,665	4,676,610	625	108,294	4,976,194
Alta	174,583	88,023	134	122,768	385,508
Bergneset	579,022	50,027	0	0	629,049
Tromsø	157,768	326,355	21,810	188,564	694,497
Narvik	21,336,587	2,030	384	7,037	21,346,038
Harstad	293,045	272,032	1,649	55,447	622,173
Sortland	635,632	52,030	47,224	75,113	809,999
Hadsel	337,144	101,492	455,839	3,358	897,833
Myre-Øksnes	213,683	76,700	0	355,403	645,786
Salten (Sørfold)	1,201,000	0	93,954	0	1,294,954
Bodø	393,944	119,578	0	0	513,522
Mo i Rana	2,869,962	85,045	78,175	1,333,533	4,366,715
Nesna	890,800	0	0	1,100	891,900
Helgeland	528,759	451,267	388,958	194,163	1,563,147
Brønnøy	1,252,767	5,516	5	637	1,258,925
TOTAL	31,276,436	6,359,200	1,108,621	2,541,034	41,235,751

5.3 Seaports based on port services

This section classifies the region's key ports based on the specialized services they offer. These services are intrinsically linked to the primary industries the seaports support. The effectiveness of any seaport is built upon a foundation of comprehensive services. In Northern Norway, a set of common services exists across most ports, including mooring assistance, basic cargo handling, power and water supply, and ship waste management. However, it is the provision of specialized and value-added services that defines a port's competitive advantage and its specific role within the regional economy. The services offered by Northern Norway seaports are summarized in *Figure 3*. Information on transport and logistics services provided by the fleet of vessels serving communities and industrial activities in Northern Norway is provided in Report 2 of this study.[71]

[71] BEAR Report 2: Maritime Transport and Logistics in Northern Norway: Current and Future Development.

The specializations of Northern Norway's major ports are determined by the balance of cargo types in their overall throughput. This has led to a clear functional classification based on the primary industries they serve.

Liquid bulk ports. The Port of Hammerfest is the exclusive export gateway for liquefied natural gas (LNG) from the Snøhvit field. The port's infrastructure and services are highly specialized for this function, with dedicated terminals for LNG carriers, mandatory escort tug services, and specific port fee structures tailored to energy transport.[72]

Bulk commodity ports. The Port of Narvik primarily serves as an export port for Swedish iron ore mined by LKAB in Kiruna, making it the largest dry bulk port in Norway. Its infrastructure is built for this purpose, featuring highly specialized ship loaders built around a naturally deep harbour. The port's operations and development have a symbiotic relationship with LKAB, as the latter is the major driver of investment and modernization of the port.[73]

Industrial ports. The Port of Mo i Rana is the logistical centre of the Mo Industrial Park, one of Norway's largest industrial clusters. It handles a diverse mix of cargo, including bulk materials for the park's steel producers, scrap metal, and finished industrial products.[74] The port features multiple specialized terminals; including the Rana Industrial Terminal (Industriterminal); an iron ore terminal for Rana Gruber; a bulk terminal with a conveyor connecting quays to storage facilities and factories; and the Toraneskaia container and general cargo terminal, which offers ro-ro facilities.[75] Its connection to the Nordland Railway makes it a critical intermodal point. The Port of Helgeland is another significant industrial port, especially its terminal in Mosjøen, which has a connection to the Nordland Railway and serves local industry such as the Alcoa aluminium plant.[76]

Fisheries and aquaculture ports. The Port of Tromsø is one of Norway's largest fishing ports. It serves as the primary export centre for frozen seafood destined for global markets in Asia and the Americas. To support this, the port offers a wide range of services, including freezer terminals and warehouses, ship repair facilities, and cargo handling capabilities.[77] Several other key seaports see large throughputs of fish and offer freezer services, including the Ports of Båtsfjord, Honningsvåg, Hadsel (Stokmarknes), Sortland, and Myre-Øksnes.

Specialized Arctic and winter services. Specialized services tailored to Arctic conditions are required for seaports to operate in a high-latitude environment. A significant strategic

[72] Equinor, "TARIFF FOR MARITIME SERVICE at Hammerfest LNG ", ed. HAMMERFEST LNG HAVN (2024). https://cdn.gac.com/prod/docs/NORWAY_Tariff-For-Maritime-service-at-Hammerfest-LNG-01.01.2024.pdf.
[73] LKAB, "Narvik: our gateway to the world," updated 30.09.2025, 2023, accessed 16.09, 2025, https://lkab.com/en/community-development/lkab-in-narvik/.
[74] Venturenorth, "Mo Industrial Park," updated 24.06.2025, 2021, accessed 10.09, 2025, https://venturenorth.no/location/mo-industrial-park/.
[75] Moshipping, "Our port in Mo i Rana," updated n.d., n.d., accessed 15.09, 2025, https://www.moshipping.no/port-of-mo-i-rana.
[76] Gen2Energy, "Agreement on the planning and design of the quay entered and application for general building permit delivered," updated 03.07.2023, 2023, accessed 08.09, 2025, https://gen2energy.com/an-agreement-on-the-planning-and-design-of-the-quay-entered-and-application-for-general-building-permit-delivered/.
[77] Troms-Fryseterminal, "Service tilbud," updated n.d., n.d., accessed 09.11, 2025, https://troms-fryseterminal.no/servicetilbud.

advantage for most of Northern Norway's mainland ports is that they remain ice-free year-round due to the warming influence of the North Atlantic Current, except for the Port of Kirkenes[78] and the Port of Båtsfjord.[79] These two seaports are responsible for icebreaking and removal of sea ice that obstructs access to their ports during the winter seasons (commonly for 2-3 months). In addition, Northern Norway experiences heavy snowfall. This makes snow clearing necessary. This service is essential for keeping quays, storage areas, and access-roads functional and safe.

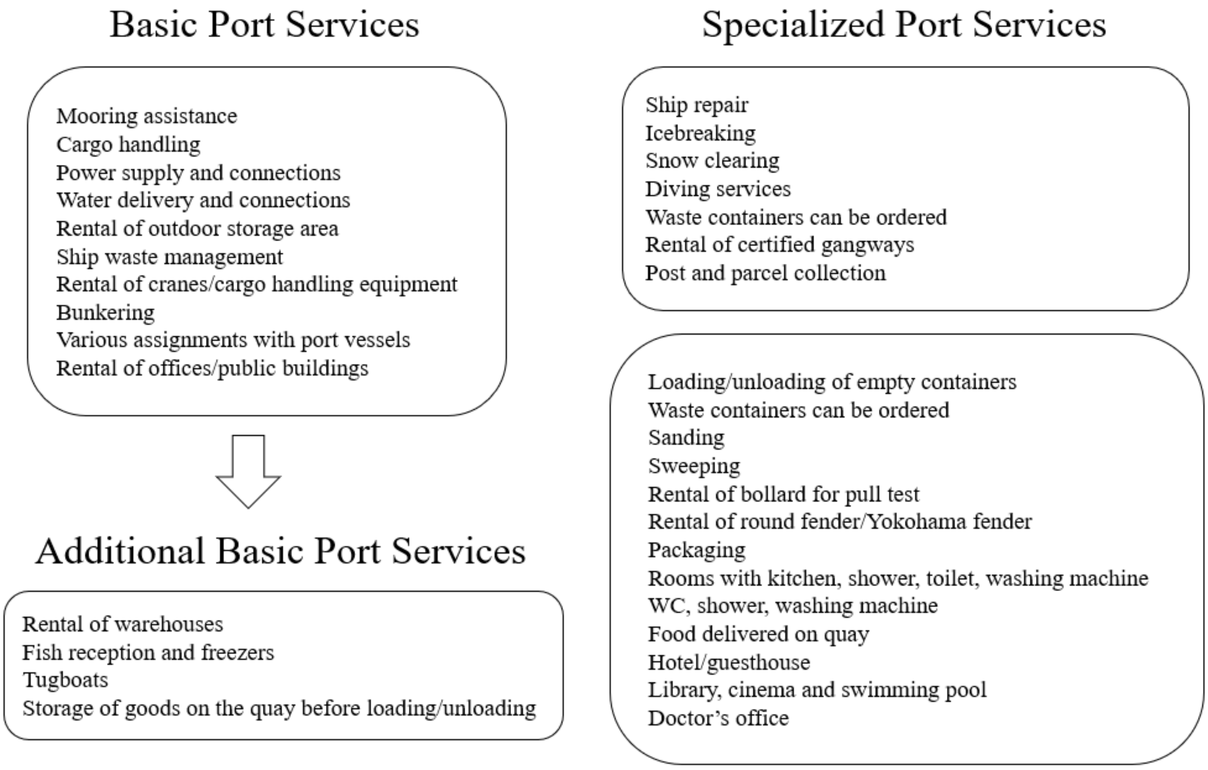

Figure 3: Combined list of basic and specialized services provided by seaport in Northern Norway. Source: Information based on websites of port authorities.

5.4 Seaports with the best intermodal transport connections

Freight terminals in Northern Norway require continued development to accommodate future traffic and to make transshipment of goods more efficient. Intermodal connections between ships and trucks are the most common in Northern Norway (*Table 7*). Several seaports in Nordland have access to the Nordland Railway, including those in Helgeland, Salten (Sørfold)[80], Mo i Rana, Fauske, and Bodø, while Narvik offers access to the Ofoten Railway. Despite these favourable connections, these seaports lack facilities for transferring goods

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[78] Kirkenes Havn, "Icebreaking - Towing - Vessel rental," updated n.d., n.d., accessed 09.11, 2025, https://kirkeneshavn.no/en/services/icebreakingtowing/.
[79] Båtsfjord Havn, *Båtsfjord Havn KF* (n.d.), https://www.visbrosjyre.no/Baatsfjord_Havn_01/MailView/.
[80] The port of Sørfold is 15km from the Nordland Railway terminal in Fauske.

efficiently between ship and rail. Freight terminals for direct transshipment between rail and truck also need to be developed. Narvik's freight terminal was recently expanded to improve transshipment between rail and truck,[81] and Narvik also has the potential to offer direct transshipment between ship and rail. Finally, some ports in Finnmark rely solely on ship-to-ship transport connections.

Table 7: Road connections to the selected seaports in Northern Norway. Source: Data collected from Statens Vegvesen (2023).

No.	Port Name	Europaveg	Riksveg	Notes
1	Port of Narvik	E6, E10		8.5 km to E10
2	Port of Hammerfest		Rv94	55 km to E6 via Rv94
3	Port of Mo i Rana	E6, E12		
4	Port of Kirkenes	E6, E105		5 km to E105 via E6
5	Port of Brønnøy	n/a	n/a	97 km to E6 via Fv76→ Fv17→ Fv76 Only county roads are available: Fv76, Fv778
6	Port of Helgeland	E6		E6 is available in Mosjøen.
7	Port of Tromsø	E8		
8	Port of Sveagruva and Port of Longyearbyen	n/a	n/a	There are no E, Rv, or Fv roads in Svalbard
9	Port of Bodø		Rv80	54 km to E6 via Rv80
10	Port of Harstad		Rv83	24 km to E10 via Rv83
11	Port of Sortland		Rv85	35 km to E10 via Fv82 → Rv85
12	Port of Alta	E6, E45		6 km to E45 via E6
13	Port of Nesna	n/a	n/a	66 km to E6 and E12 via Fv17 → Fv810 Only county roads are available: Fv17, Fv380, Fv382, Fv386. Among them, Fv17, Fv382, Fv386 include ferry services
14	Ports of Myre, Stø, Alsvåg, and Øksnes	n/a	n/a	Around 70 km to E10 via Fv821→ Fv820→ Rv85 Only county roads are available: Fv820, Fv821, Fv7668, Fv7674
15	Port of Hadsel	n/a	n/a	26 km to E10 via Fv82, including a ferry. Only county roads are available: Fv7634, Fv82
16	Port of Bergneset	E6, E8		10 km to E8 via E6
17	Port of Båtsfjord	n/a	n/a	106 km to E6 via Fv891→ Fv890 Only county roads are available: Fv891

[81] Narvik Havn, *Strategisk plan for Narvik Havn 2022-2025*.

No.	Port Name	Europaveg	Riksveg	Notes
18	Port of Honningsvåg (Nordkapp, Lebesby og Porsanger)	E6, E69		E69 is available in Honningsvåg and Nordkapp; Both E6 and E69 are available in Porsanger; Fv888 is available in Lebesby
19	Port District of Salten (Sørfold)	E6		

Table 8: Seaports in Northern Norway with railway connection.

No.	Port Name	Railway Connection	Notes
1	Narvik	Ofoten Railway	The Oslo-Narvik section of the Ofoten Railway, which passes through Sweden, is 1,960 km long with a travel time of 26-30 hours[82]
2	Bodø	Nordland Railway	
3	Helgeland	Nordland Railway	Only Mojøen has railway connection
4	Mo i Rana	Nordland Railway	
5	Port District of Salten (Sørfold)	Nordland Railway	Only 15 km away from Fauske Railway Station via European Road E6

5.5 Seaports in international trade

Seven of the seaports in Northern Norway are active in international trade: the Ports of Narvik, Hammerfest, Helgeland, Mo i Rana, Salten (Sørfold), Hadsel (Stokmarknes), and Sortland. The majority of the cargo volume passing through these ports consists of bulk exports, including iron ore concentrate from Narvik, LNG from Hammerfest, and iron ore concentrate and industrial minerals from Mo i Rana. Other industrial products are exported in containers or as general cargo, including steel, aluminium, and other metal products from Helgeland and Mo i Rana. Many of the other ports do export some goods in containers or as general cargo, but the volume of these is relatively small (e.g., export of frozen seafood by refrigerated cargo vessels).

5.6 Development plans for the seaports

Most of the 21 seaports in Northern Norway have their own expansion plans, with many of these focusing on containerized cargo. These development plans commonly include the construction of deepwater quays to accommodate larger vessels, improvements to cargo handling facilities, and the establishment of industrial areas and cargo storage facilities (*Table 9*). However, because there is no overarching port governance structure, holistic regional planning and solutions are lacking. Ports located in the same general area commonly do not

[82] Narvik Havn, "Knutepunkt Narvik," updated 15.02.2023, 2022, accessed 09.11, 2025, https://www.narvikhavn.no/knutepunkt-narvik/.

collaborate on future infrastructure plans.[83] As discussed in the next section, this can lead to inefficiencies as each municipality plans its own port expansions without thinking beyond municipal borders. Some degree of port specialization is warranted based on the type of industry in the port's surrounding area. Many ports, however, find their growth prospects limited by a lack of access to large hinterland areas.

Table 9: Development plans for seaports in Northern Norway.

Port	Port development plan
Bodø	(a) Construction of the New Bodø Terminal at the city centre and improvement of intermodal rail-sea transshipment facilities (Nordland railway). (b) Establishment of regular container transport services by sea between Bodø and Tromsø.
Narvik	(a) New deepwater terminal for the transportation of iron ore from Sweden (Kiruna) and improvements to intermodal rail-sea transshipment facilities (Ofoten Railway). (b) Cooperation with the Port of Lødingen to establish Hålogaland Business Park. (c) Expansion of container, bulk, and pelletized cargo capacities. (d) Capitalizing further on Narvik's status as the EU's northernmost Core Port.
Tromsø	(a) Restructuring of Breivika Terminals in the city centre, including construction of a small container area. (b) Expansion of Grøtsund Industrial Park in Tønsnes with industrial and deepwater quay. (c) Further development of the Freezer Terminal in Tromsø which currently stores about 250,000 tonnes of fish each year.
Harstad	Development of the Rødskjær Business Park (connected to highway E10) with a focus on waste collection and recycling, and shipments to large recycling facilities in the EU.
Kirkenes	Longstanding plan to relocate the international export terminal from the Kirkenes town centre to another location in the Varangerfjord; this is linked to the potential construction of a railway to Finland and predicted demand for container shipping along the Northern Maritime Corridor and the Northern Sea Route (NSR).
Hammerfest	Development of the port in the centre of Hammerfest as part of the "Clean Port Project" (Ren havn). This will involve excavating and disposing of contaminated sediments, building new quay structures (400 m); creation of new land for business activities; and expanding the port's capacity.
Mo i Rana	The new Rana Industrial Terminal at Langneset (connected to and owned by Mo Industrial Park) with planned deepwater quay (15 m) and easy access to the Nordland Railway, the airport (14 km), and E6. The site is flat and well suited for storage, logistics, and larger industrial activities (80,000m2). Th project will significantly enhance Mo i Rana's cargo handling capabilities.

[83] Informant LS23 (2023); Informant PA16 (2023); Informant PA17 (2023).

Port	Port development plan
Helgeland (Mosjøen and Sandnessjøen)	(a) A plan for a new container terminal at the port in Mosjøen which will facilitate efficient transfer of containers from sea to rail (Nordland Railway). (b) Further development at the Horvnes port and industrial area in Sandnessjøen in support of offshore supply services and other industrial activities.
Sortland	The Blue Hub Project involves the establishment of a large new industrialized port area located outside the town centre, with a strong focus on container transport, especially related to the transportation of fish and aquaculture products. The expansion of the port includes Kringelen, a planned 700,000 m2 area with deepwater dock (20 m).
Hadsel (Stokmarknes)	The Environmental Port Project (Miljøhavn) at Stokmarknes includes construction of a 180-meter-long quay and 800,000 m2 industrial area. The project plans to increase exports by sea of aquaculture and fish-feed products in refrigerated containers.
Bergneset (Balsfjord)	Ongoing discussion of constructing a deepwater quay to better support the growing needs of local industries, including facilities for transporting sand, gravel, and aggregates, along with fish feed.
Honningsvåg	The fjord north of the port is a strategic location for ship-to-ship transshipment of containers transported by container vessels sailing along the Northeast Passage between NW Europe and NE Asia.
Alta	Plans are being developed for the construction of a new multi-purpose quay (400 m) which will be able to accommodate large cruise ships, and a multi-use facility for other transport activities.
Nesna	The Port of Nesna will benefit from the future development of the Nesna Industrial Park, which will include a site for industrial activities with access to a deepwater quay.
Myre-Øksnes	The Port of Myre-Øksnes is focused on fisheries and aquaculture like the nearby Port of Sortland. A new quay with wave attenuation is under construction in Myre.
Longyearbyen	The Port of Longyearbyen has three quays of limited capacity as the shipping season is short. Most of the port activities are oriented toward the support of cruise ships. A possible government-led port infrastructure project for Longyearbyen has been discussed in support of Svalbard policy objectives.

6. Challenges Facing the Seaports

6.1 Demographic challenges and long shipping distances

About 480,000 people live in Northern Norway. Most urban centres and municipalities in Northern Norway suffer from population decline and a growing urban-rural divide. The working-age population is diminishing, with the only growing demographic being people aged sixty and older. This trend of southward migration of young people and families to the capital area and other large urban centres in the southern part of the country has also been seen in Northern Sweden and Northern Finland and presents a threat to the region's long-term sustainability. In Northern Norway, the only exceptions are the cities of Bodø and Tromsø, which have growing populations and attract young people because of their large regional universities. This development, if left unaddressed could seriously undermine future business and investment opportunities in the North. These demographic trends raise a critical question for policymakers: How can the region attract new talent and reverse the current migration patterns? Northern Norway's location at the northern edge of Europe, far from major trade routes, with the very long and irregular coastline and large number of islands characteristic of fjord landscapes, together with relatively small and dispersed population, makes the region a classic feeder and short sea market with many small ports rather than a few large central ones.[84]

6.2 Limited state funding and decentralized port governance

The Norwegian government has long had the goal of increasing the portion of goods that are transported by sea and rail rather than by road.[85] According to our informants, this policy has not been successful. Public investments in seaport infrastructure are critical for maintaining and upgrading the maritime transportation system, but a cohesive state strategy is currently lacking. The government currently allocates only 3% of its total spend under the National Transport Plan 2025-2036[86] to the maritime sector, and only a small part of that goes to improving the seaport infrastructure in Northern Norway. Informants highlighted this imbalance in resource allocation for the maritime sector and that Northern Norway feels overlooked.[87] The current state subsidies mechanism also drew criticism, with several informants calling for a revised system to better serve the purpose of cargo transport by sea.[88]

Currently, the majority of port revenues come from port charges and rental income from real estate. Revenues from real estate often exceed 50% of total revenues in urban ports. This heavy reliance on real estate results in the situation where ports act more as property developers than logistics facilitators. It encourages port authorities to prioritize high-yield commercial real estate (offices and apartments) over lower-yield maritime logistics space, threatening the long-term availability of port capacity in growing cities.

Another key issue is port governance. Norwegian public ports are owned by regional municipalities and managed by local port authorities. Municipalities on the county level have also become owners of certain port infrastructure. Specific port services, however, are commonly operated and managed by private companies. This leads to variations in the organization, operation, and management of seaports,[89] and high degrees of autonomy.

[84] Such systems have also been termed regional or secondary container port systems. Unlike the deep-sea shipping market for containers on long-haul routes between Europe and Asia, the feeder and short-sea shipping market in the EU is generally fragmented and underdeveloped and lacks alliances among shipping and logistics providers; Olaf Merk and Theo Notteboom, "Port hinterland connectivity" (2015).

[85] Samferdselsdepartementet, Short Nasjonal transportplan 2018–2029.

[86] Samferdselsdepartementet, Nasjonal transportplan 2025–2036 Meld. St. 14 (2023-2024), (2024).

[87] Informant CO1 (2023).

[88] Kystverket, Tilskudd til godsoverføring fra vei til sjø, (2021).

[89] Kystverket, "Struktur og eierskap," updated n.d., n.d., accessed 09.11, 2025, https://www.kystverket.no/havn/struktur-og-eierskap/.

According to our informants, this decentralized approach to operations and investments, compounded by a complex regulatory landscape, significantly hampers the deployment of efficient and standardized logistical practices, and leads to inefficiencies and escalating costs.[90] Other studies have come to the same conclusion,[91] namely that the ports are managed in accordance with the goals of their respective municipalities, which do not necessarily coincide with the goals of the larger region or the central government, leading to an indecisive port management structure.

Perhaps because of this organizational and management approach, there has been limited collaboration among public and private maritime stakeholders. This leads to lack of cooperation among cargo owners and shipping companies, and among the logistics operators themselves, to improve the port structure and find common solutions to the transport needs of Northern Norway. Port reform has been suggested by the Norwegian government to reduce the competition between smaller ports and achieve economies of scale. As mentioned earlier, this could be done through the merging of neighbouring ports and the establishment of regional port authorities led by the central government. Central government oversight is important to both guarantee that regional port management decisions are aligned with government policies and to ensure direct access to state funding.

Private ports, on the other hand, are often highly specialized and adapted to the needs of a single or few private companies that are located at or near the port, to minimize logistics costs and reduce the need for road transport.[92]

6.3 Low cargo volume and large number of ports

Low cargo volumes are typical of feeder/short sea shipping and coastal shipping in peripheral regions with low populations, located far away from larger markets and shipping routes.[93] In addition, Northern Norway has a large number of small ports, where low cargo volumes lead to low service frequency, small vessel sizes, and slow cargo handling at ports.[94] As a result, vessels tend to carry a mix of standardized containers and bulk cargo. Calling at multiple ports over short distances to either collect cargo from or deliver cargo to several remote coastal communities leads to high port fees, cargo handling charges, and personnel costs, which contribute to high overall transport costs. Despite attempts to fill space on board by making multiple stops, according to our informants, “many voyages are done by half-empty vessels, wasting fuel and impacting the overall sustainability of operations”.[95] These services would likely not remain competitive with land-based transport without some form of government subsidies.[96] Subsidies are currently provided by policymakers in the name of

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90 Informant LS15 (2023).
91 Øystein Hop, *Norwegian Ports. Framework Conditions and National Port Structure* (1995), https://www.toi.no/publications/norwegian-ports-framework-conditions-and-national-port-structure-article18201-29.html.; Lukas Höller, "Porous Kirkenes: Crumbling Mining Town or Dynamic Port Cityscape?," *Urban Planning* 6, no. 3 (2021).
92 Steen et al., "Implementing decarbonisation measures in Norwegian ports."
93 Bahana Wiradanti, "Container hub port development in a peripheral location: The case of Indonesia" (Cardiff University, 2019).
94 AC Paixão and Peter B Marlow, "Strengths and weaknesses of short sea shipping," *Marine policy* 26, no. 3 (2002).
95 Informant CO25 (2023).
96 Kystverket, Short Tilskudd til godsoverføring fra vei til sjø.

regional development and with the rationale that short sea shipping is more environmentally friendly than road transport.

Feeder/short sea shipping commonly faces fierce competition from land-based transport where the same locations can also be serviced by road or train. This competition may be restricted if origin and destination ports are in areas where a natural basin makes sea distance significantly shorter than road; however, despite the fact that this is the case in several regions in Western and Northern Norway, road transport is often favoured due to its flexibility, shorter delivery times, and more frequent deliveries, particularly with perishable produce and other consumer goods, as well as building and construction materials.

Aquaculture and fisheries in remote coastal communities in Northern Norway largely rely on large trailer trucks (and, in Nordland and Ofoten, railways) rather than seaports to transport their fresh farm-raised salmon and fresh wild-caught cod southwards to European markets; . Transport of such fresh produce currently cannot be undertaken by ships due to the much longer travel times compared to road transport, which would greatly impact the quality of the perishable goods by the time they reach their destinations. Additional processing of the fish would be required, such as vacuum packaging and super-cooling technology to extend the shelf-life of the produce by several days. Frozen seafood and dried or salted fish is, however, commonly transported by sea to the European market from several seaports in Northern Norway.

An additional challenge is the common cargo imbalance in the commodity industries. Northern Norway's major industries revolve around the exploitation of natural resources and rely on regular export shipments of their commodities to international markets. Imports of supplies and additional materials are much smaller than these exports, resulting in a large cargo imbalance. As mentioned above, for coastal shipping, this lack of returning cargo leads to empty or near empty bulk carriers sailing long distances from the south up to Northern Norway to be reloaded with commodities for the return voyage back to international markets.[97]

6.4 Limited port services and cargo handling capacity

There is a pressing need for the modernization and expansion of port facilities to better accommodate innovative transport solutions.[98] Several of the ports in Northern Norway have limited infrastructure and low levels of automation.[99] Consequently, such ports are typically frequented by multipurpose cargo vessels that rely on their own loading and unloading equipment. Some ports also face significant capacity limitations, which impede cargo handling for critical periods during the peak season, but face constraints in securing adequate funding for near-term efficiency enhancements. This can lead to significant logistical bottlenecks.[100] Lack of coordination between different modes of transport also leads to unnecessary bottlenecks and delays. Stakeholders describe some seaports as overcrowded during peak season, leading to scheduling conflicts, unavailability of port space, delays in

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[97] Informant CO20 (2023).
[98] Informant PA16 (2023).
[99] Mariann Merz et al., "A gap analysis for automated cargo handling operations with geared vessels frequenting small sized ports," *Maritime Transport Research* 5 (2023).
[100] Informant PA15 (2023).

receiving materials onboard, or reloading of vessels not taking place at the prescheduled times.[101]

Ports struggle to offer competitive services due to increased operational costs and the need for more extensive use of port facilities [102] and outdated cost structure for port services. Smaller ports find it difficult to adopt a cost-reduction mindset that could enhance their attractiveness and cargo handling.[103] Lacking such capabilities hinders their ability to optimize logistics and, as a result, the region's overall ability to utilize sea transport to its fullest potential.[104] Several smaller seaports have depth and width constraints at quays that limit access for larger vessels. Other ports have tidal ranges of several meters between high and low tide, affecting the use of roll-on and roll-off vessels and limiting capacity to increase cargo transport by sea.

The reliance of the aquaculture industry on road transport has provided limited incentives to +increase the capacity of fishing ports for handling more cargo for transport by sea. As pointed out by one informant, “lack of funding of fishing ports over many years has led to the fact that today there are large maintenance and renewal needs”. This can be seen in the lack of support infrastructure such as warehousing and storage capacity, which limits the supply chain services logistics providers can offer at these ports. The facilities required to maintain constant temperature for refrigerated containers with perishable goods such as seafood would also be essential to increasing the use of seaports for exporting these products.[105] There are also marked differences in seaport capacities and services between larger and smaller seaports. Some seaports have developed specialized services for local industries, such as shipyard and service facilities used by fishing fleets and export-oriented companies in power-intensive industries. Ports that implement more advanced solutions to achieve flexibility and efficiency in cargo handling operations have greater growth potential than ports holding on to outdated practices.

6.5 Challenges of intermodal integration

Not all seaports in Northern Norway are economically viable due to low cargo volume and high operational costs. Efficiency pressures favour the use of larger ports (e.g., Bodø, Narvik, Tromsø) as logistics and service hubs. Developing such logistics hubs is vital for enhancing the capacity, predictability, and overall quality of the supply chain in the region.[106] Combining railway and maritime transport can significantly increase transport efficiency.[107] Access to rail is also critical because of the limited capacity and poor condition of the road network.[108] Severe weather in Northern Norway has underscored the need for safety and flexibility. Our informants also highlight that logistics hubs must have easy access to airports.[109]

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[101] Informant CO25 (2023).
[102] Informant LS14 (2023); Informant PA19 (2023).
[103] Informant PA15 (2023); Informant CO21 (2023).
[104] Informant PA22 (2023).
[105] Informant CO21 (2023).
[106] Informant LS14 (2023); Informant LS15 (2023); Informant LS15 (2023).
[107] Informant PA15 (2023); Informant CO21 (2023); Informant RL1 (2023); Informant PA14 (2023); Informant CO25 (2023).
[108] Informant CO25 (2023).
[109] Informant LS14 (2023).

From 2003 to 2013, container cargo from the Oslo region was typically transported by rail to the Port of Bodø and then by a single container vessel to the Port of Tromsø. The average yearly throughput on this vessel during the ten years was about 20,000 TEUs. The container vessel operating the route was old and in need of refit or replacement, but the risks and costs were too high for a major logistics company to find undertaking this process economically sound.[110] The container volume handled by the Port of Bodø dropped to 25 containers in 2014 and zero in 2015. This caused repercussions for other ports north of Bodø as well, with a reduction of over 80% in container volumes for the Port of Tromsø. This exemplifies how vulnerable many ports in feeder systems can be because of small container volumes, which is a further rationale for port consolidation.[111] Container transport to Tromsø is now done by trailer trucks.

7. Development Strategies for Seaports in Northern Norway

7.1 Design of short-sea feeder networks

Large container companies design their transportation services between global markets based on a hub-and-spoke model.[112] Such a system increases market connections and reduces costs through transshipments of goods from major hubs to much smaller feeder ports, serviced by small feeder vessels. Feeder networks[113] are optimized by determining the optimal size of the feeder fleet and developing designated sailing routes between ports to minimize both operational costs and transfers. Msakni et al. (2020)[114] proposed a feeder network design (FND) which included transshipment for a small shipping company (North Sea Container Line) already transporting containers between European ports such as Rotterdam and ports on the Norwegian western coast and up to Nordland in Northern Norway (Glomfjord, Salten and Hadsel/Stokmarknes). The shipping company provides this feeder service on a weekly basis and on scheduled routes, currently serving twenty-one Norwegian ports with a fleet of five vessels (each 700-900 TEUs). Holm et al. (2019)[115] did a similar study for the same shipping company but included the possibility of ship-to-ship transshipment of containers at sea, rather than in ports. In both proposals, the feeder vessels transporting containerized goods between European hubs and selected Norwegian ports were defined as “mother vessels”, with much smaller “daughter vessels” transporting goods locally (*Figure 4*).

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[110] Svindland, Monios, and Hjelle, "Port rationalization and the evolution of regional port systems: the case of Norway."

[111] Svindland, Monios, and Hjelle, see note 110

[112] A hub-and-spoke network is a logistics model that organizes transport and distribution around a central facility, known as a "hub." In this system, instead of running direct, point-to-point services between many different origins and destinations, traffic is first collected from multiple origin points (the "spokes") and consolidated at the central hub. At the hub, this consolidated volume is sorted and then redistributed out to the final destinations (the other "spokes"); Jean-Paul Rodrigue, *The geography of transport systems* (Routledge, 2020).

[113] Erik Orm Hellsten, David Sacramento, and David Pisinger, "A branch-and-price algorithm for solving the single-hub feeder network design problem," *European Journal of Operational Research* 300, no. 3 (2022).

[114] Msakni et al., "Analyzing different designs of liner shipping feeder networks: A case study."

[115] Holm et al., "Shortsea liner network design with transhipments at sea: a case study from Western Norway."

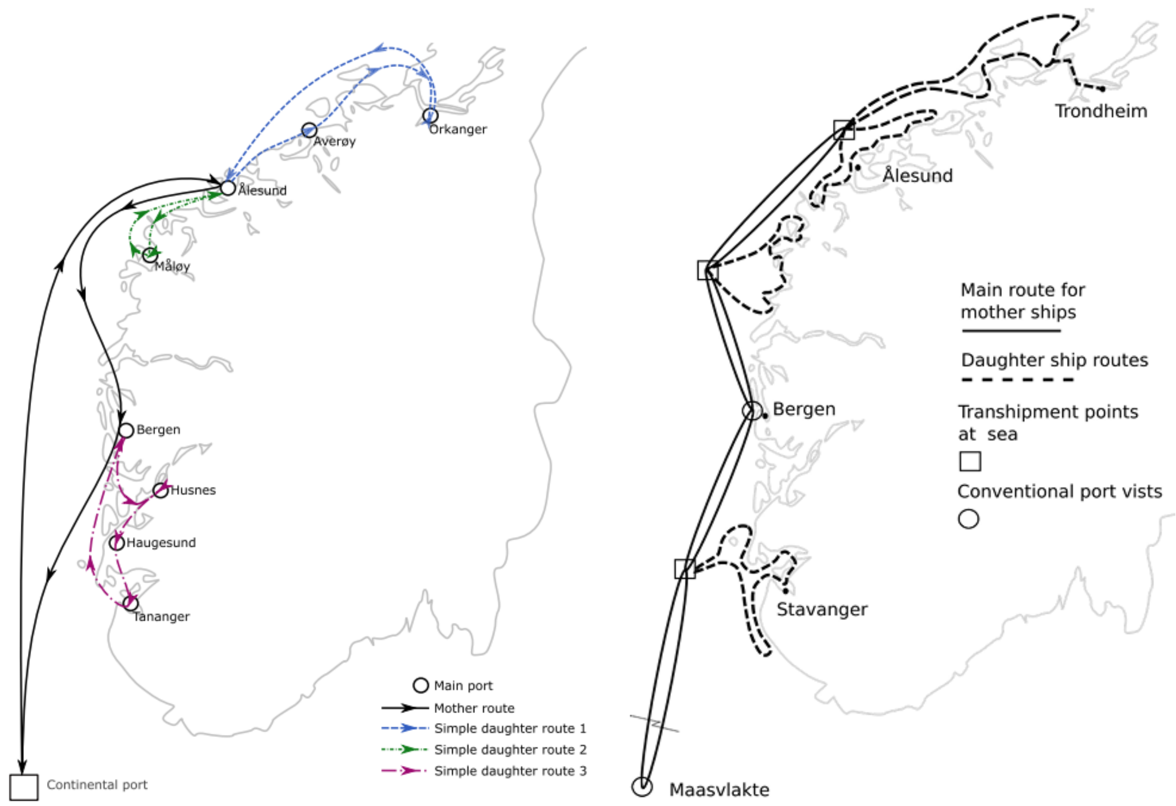

Figure 4: Feeder-network-designs with transshipment along the western coast of Norway (Source: Msakni et al., 2020 and Holm et al., 2019).

Both studies highlighted that mother-daughter routes must be synchronized to facilitate cargo transshipment. The use of daughter vessels allows mother vessels to be bigger as they do not have to call at the smaller ports, supporting economies of scale. Smaller daughter vessels could transport containers from regional container terminals to locations as close as possible to the final cargo destinations, promoting a regional modal shift from road to sea transport at the final stage of the supply chain. Such a port development strategy was, for example, suggested for the Port of Bergen by Ormevik et al. (2020).[116] Given the topography of Bergen and its surroundings, with many fjords and islands, establishing such a network would provide cost savings through maritime shortcuts, reducing the need for road transportation.[117] This likely applies to other port cities along the Norwegian coastline.

[116] Ormevik, Erikstad, and Fagerholt, "Evaluating port development strategies for a modal shift: a Norwegian case study."

[117] Geir Berg and Hans Kristian Haram, *Flytting av godshavna i Bergen til Ågotnes-konsekvensanalyse.*, Flowchange AS (2018), https://fido.nrk.no/cef4c2d4d96346d5511114237d6072a6a7601eb97fc526f5ceb11102c261b082/Konsekvensanalyse%20flytting%20Bergen%20godshavn%20-%20Flowchange%20as.pdf.

7.2 Seaports as decarbonization centres in the green energy transition

Norway is a leader in the development and implementation of low- and zero-emission energy alternatives to conventional fossil fuels for shipping. The reduction of greenhouse gas emissions from domestic shipping has been high on the national policy agenda in recent years.[118] Ports can implement various measures to address climate- and energy-related issues and reduce the environmental impacts of port activities. The Norwegian government's vision[119] for the nation's ports is to become integrated energy hubs for both shipping and onshore industrial activities by providing onshore power supply (OPS[120]) and connecting ships to shore power during berthing, and by providing facilities for the production and distribution of alternative energy sources (e.g., hydrogen, ammonia, methanol, battery-electric).[121] The ports are envisioned to develop into future "decarbonization hubs" and become major contributors to the energy transition.

Because the ports operate at the intersection between land and sea and may host energy-intensive onshore industries, they are in an advantageous position for becoming hubs for the energy transition to low- or zero-emission fuels. Damman and Steen (2021)[122] named four interacting site-specific factors important to facilitate such an energy transition at Norwegian ports: (1) the amount of traffic at the port; (2) preexisting infrastructure; (3) local industry; and (4) availability of renewable energy sources. Each of these factors is complex, and, together with safety concerns, needs to be supported by strict regulatory measures, skilled personnel, and public and private funding. Otherwise, port authorities are likely to both lack the financial means and the expertise to provide expensive new energy infrastructure solutions on their own. This concerns smaller ports.

Steen et al. (2024)[123] conducted a survey of 96 ports in Norway to identify the main drivers and barriers associated with the implementation of low- and high-voltage OPS and alternative fuels. OPS has already been widely implemented in Norwegian ports, driven by generous public funding schemes that have funded more than 90 shore power facilities, and further supported by a national electricity surplus in Northern Norway. However, high voltage OPS providing power in the megawatt range (e.g. for cruise vessels and international ferry services) would require investments in additional renewable energy and grid infrastructure, which could be very costly in some geographical locations.[124]

[118] Regjeringen, The Government's action plan for green shipping, (regjeringen.no, 2019).

[119] Samferdselsdepartementet, Short Nasjonal transportplan 2018–2029.

[120] OPS involves connecting ships to shore power during berthing, allowing them to use electricity from the shore for lighting, heating, and cooling instead of running their onboard generators.

[121] DNV-GL and Eurelectric, "Port: Green Gateways to Europe - 10 Transitions to turn ports into decarbonization hubs," dnv.com, 2020, https://www.dnv.com/publications/ports-green-gateways-to-europe-179372/. ; Markus Steen et al., "Greening the fleet: A technological innovation system (TIS) analysis of hydrogen, battery electric, liquefied biogas, and biodiesel in the maritime sector," *SINTEF report*, no. 0093 (2019).

[122] Damman and Steen, "A socio-technical perspective on the scope for ports to enable energy transition."

[123] Steen et al., "Implementing decarbonisation measures in Norwegian ports."

[124] Anna Bergek et al., "Sustainability transitions in coastal shipping: The role of regime segmentation," *Transportation research interdisciplinary perspectives* 12 (2021).

All ports operations in both Norway and the EU are required to use zero-emission energy by 2030, and all ports will need to provide OPS to ships at berth.[125] About 53% of the surveyed ports in Norway had implemented OPS, but only 14% provided some forms of alternative fuels, with most of these being larger ports, suggesting that significant barriers to implementation remain.[126] Unlike OPS, the government has been less specific on the implementation of alternative fuels, relying more on collaboration among key stakeholders to determine the scale and types of alternative fuels to be used. Production and distribution of alternative fuels are technically complex endeavours facing ongoing uncertainty in terms of capacity,[127] a fact reflected in the limited user demand from shipowners to date.[128]

7.3 Smart seaport initiatives to enhance port performance

Given the high labour expenses in Norway, automation can yield substantial savings. Smart ports are emerging as a promising solution to address the evolving challenges in international trade and logistics systems. Over the past decade, significant digital transformation and automation have taken place at ports worldwide, particularly major container ports, leading to continuous improvements in port performance and reduction in operational costs.[129] By integrating digital technologies and electrifying cargo handling equipment, smart ports can greatly increase their capacity and optimize resource allocation in their operations. However, successful integration of smart systems requires strong collaboration and involvement from stakeholders.[130]

Wu et al. (2013)[131] define smart seaport as those which have facilities and infrastructure supporting various smart functions, automation, digitalization, efficiency of operations (seamless connection among internal facilities and external port users), real-time information sharing with stakeholders, and smart management and planning. The port operation management system supports decision-making regarding customer relations, freight, finances, and environmental management. Human resource management focuses on offering continuous training to meet the evolving demands of smart ports.[132] Smart systems also

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[125] EU, "Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU (Text with EEA relevance)," in *L 234/1*, ed. European Union (2023). https://eur-lex.europa.eu/eli/reg/2023/1804/oj/eng.

[126] Steen et al., see note 123.

[127] Dorthe Alida Slotvik et al., *Nordic Roadmap - Future Fuels for Shipping - Insight On Green Shipping Corridors - From policy ambitions to realization* (2022), https://futurefuelsnordic.com/wp-content/uploads/2022/11/Green-Corridor-Paper_Nordic-Roadmap.pdf.

[128] Tuukka Mäkitie et al., "Norwegian ship-owners' adoption of alternative fuels," *Energy Policy* 163 (2022).

[129] Alzate et al., "Operational efficiency and sustainability in smart ports: a comprehensive review."; Hayder Ali Al-Fatlawi and Hassan Jassim Motlak, "Smart ports: towards a high performance, increased productivity, and a better environment," *International Journal of Electrical & Computer Engineering (2088-8708)* 13, no. 2 (2023).

[130] Yavuz Keceli, "A proposed innovation strategy for Turkish port administration policy via information technology," *Maritime Policy & Management* 38, no. 2 (2011).

[131] Yunjian Wu et al., "Study on intelligent port under the construction of smart city" (paper presented at the Proceedings of 2013 IEEE International Conference on Service Operations and Logistics, and Informatics, 2013).

[132] Anahita Molavi, Gino J Lim, and Bruce Race, "A framework for building a smart port and smart port index," *International journal of sustainable transportation* 14, no. 9 (2020).

enhance security through infrastructure such as facial recognition, trajectory tracking, motion detection, and video surveillance.[133]

The vast amount of data processed by such technologies, combined with the closer connections between logistics parties, has led to increased cybersecurity risks. De la Peña Zarzuelo (2021)[134] argues that cybersecurity considerations and the possibility of cyberattacks in ports expand the scope of traditional port safety and security philosophy.

Another recent trend highlights the necessity of implementing smart and sustainable logistics to prioritize the well-being of citizens and the quality of life in port cities. Researchers now view ports and their associated cities as interconnected ecosystems, considering not only pollution from seaport activities but also their broader environmental impact. Developing a smart city-port ecosystem, where technologies like the Internet of Things are utilized for sensing, monitoring, and managing processes, can significantly benefit both cities and ports. Sensors and smart infrastructure have the potential to reduce or prevent negative impacts on citizens, such as noise, air pollution, and the spillage of hazardous substances into water.[135]

Though progress towards smart ports is considered irreversible, it will require several years of development for the application of this technology in a port to reach a mature stage.[136] The cost of constructing new physical and digital port infrastructure will be substantial. Adoption of autonomous vessels also necessitates changes or reconfigurations in port infrastructure. Equally important is the need for cooperation among all involved parties and between individual port facilities in embracing new digital communication and information systems. To date, digitalization and automation is still very limited in Norwegian ports,[137] though there are a handful of projects testing the feasibility of small autonomous container vessels for operations in coastal waters in both Southern and Western Norway.[138] However, substantial opportunities remain for future development.[139]

In Norway the focus has been on emission-free or low-emission technologies[140] including electrification of port operations, OPS, and the use of battery-electric ships and those running on alternative fuels (e.g. hydrogen, ammonia). Additional focus has been on improving energy

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[133] Qingwei Wang, Xiaolong Zhang, and Xiaofeng Li, "Facial feature point recognition method for human motion image using GNN," *Mathematical Biosciences and Engineering* 19, no. 4 (2022).
Peter Kok-Yiu Wong et al., "Recognition of pedestrian trajectories and attributes with computer vision and deep learning techniques," *Advanced Engineering Informatics* 49 (2021).
[134] Ignacio de la Peña Zarzuelo, "Cybersecurity in ports and maritime industry: Reasons for raising awareness on this issue," *Transport Policy* 100 (2021).
[135] Bojan Beškovnik and Patricija Bajec, "Strategies and approach for smart city-port ecosystems development supported by the internet of things," *Transport* 36, no. 5 (2021).
[136] A Karaś, "Smart port as a key to the future development of modern ports," *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation* 14, no. 1 (2020).
[137] Steen et al., see note 123.
[138] YARA, "Yara Birkeland ", updated 01.09.2022, 2021, accessed 10.11, 2025, https://www.yara.com/news-and-media/media-library/press-kits/yara-birkeland-press-kit/.; Ragnar Bøifot, "Lødingen tar et nytt steg mot Narvik," fremover.no, updated 28.12.2022, 2022, accessed 10.11, 2025, https://www.fremover.no/lodingen-tar-et-nytt-steg-mot-narvik/s/5-17-1052626.; DB Scenker, "DB Schenker plans to operate a zero-emission autonomous coastal container feeder for Ekornes ASA in Norway," updated n.d., 2022, accessed 10.11, 2025, https://www.dbschenker.com/id-en/autonomous-vessel-norway-1128930.
[139] SINTEF and TCOMS, *R&D Roadmap for Smart & Autonomous Sea Transport Systems* (2020), https://www.sintef.no/en/latest-news/2020/a-roadmap-for-smart-and-autonomous-sea-transport-systems/.
[140] Steen et al., see note 123.

efficiency in ports overall. Less attention has been given to the digitalization and automation of port operations. Operational challenges for autonomous port vehicles and cranes will also be considerable, during both loading and unloading of cargo to and from autonomous vessels. The challenges will be even greater for bulk cargo than for standardized containers.[141] Also, ports will need to accommodate vessels with different levels of automation. Cooperation in a future maritime transport system could therefore be between unequal actors, involving both conventional and automated vessels and several control centres. This fact might further promote the future development of highly specialized sports, only serving highly specialized vessels.

Approximately 90% of all goods transported between Norway and foreign markets move by sea. This makes the maritime sector not only an economic engine, but also the primary lifeline for national supply security. The report Status 2025 outlines the Total Defence concept. A port can no longer simply be efficient; it must also be resilient. Smart ports should also accommodate military logistics capabilities. This requires digital systems that are secure against cybersecurity threats and physical infrastructure (quays, laydown areas) that can handle heavy military equipment alongside commercial cargo. The HAVINOR platform represents the Norwegian maritime sector's response to digital transformation. It is a digital collaboration platform developed to modernize and streamline port operations across the country, providing a unified framework that connects port authorities, service providers, customers, and other users.

7.4 Floating port infrastructure

Topographic features in Norway are characterized by an uneven and generally elevated landscape, with many fjords and islands. This has forced coastal cities and towns to construct several small terminals along the coastline in different locations but within the same general area, wherever suitable land could be found. These terminals might belong to the same port authority despite distances of several kilometres between them. These difficulties with port construction as a result of limited suitable land for construction are further complicated by very hard bedrock, requiring extensive drilling and use of explosives, making port construction very expensive. Additionally, many ports must contend with shallow water along the coastline.

Ports and terminals have therefore been constructed where land was most suitable for construction, that did not always correspond with the best strategic port location. This helps to explain the development of a large number of small ports in Norway rather than a few larger ports in more strategic locations. These same landscape and bedrock features also make road and railway construction very challenging and expensive. In many larger coastal cities, there is also a constant demand for more usable space to meet the development and economic needs of an increasing population. In this respect, the use of coastal sea space, where available, is a viable solution to address the issue of land scarcity.

One possible solution to these concerns in the bid to increase land space would be to extend port facilities further out into the sea through the construction of floating offshore structures

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[141] Merz et al., "A gap analysis for automated cargo handling operations with geared vessels frequenting small sized ports."

(*Figure 5*). Floating structures have been used in offshore engineering since the 1970's. Floating port structures such as breakwaters, piers, barges, and larger platforms can be constructed by connecting several modular caissons, mainly made from concrete, to create desired port structures.[142] Such floating structures in coastal areas have been built in several countries. The fjord landscape in Norway, which provides amble protection against high waves and bad weather but is also characterized by deep waters and large tidal ranges, is ideal for such floating structures.

The use of floating structures is also preferable to the conventional approach to land reclamation that involves dumping sands or rocks into the sea, as the former is more environmentally friendly and less time consuming in construction. Moreover, the weight of floating structures is automatically balanced by the buoyancy force, thus eliminating the need for massive and expensive foundations, which in turn results in savings in material and construction costs.

Floating structures are likely to become increasingly important for maritime and industrial development over time. Concrete gravity-based structures (GBS)[143] could, for example, provide the foundation for various resource extraction and industrial activities, including near-shore power generation and ore processing plants, as well as various marine structures for harbour and terminal construction. Industrial units can be reassembled onto the floating GBS foundations at large construction yards and then towed to a desired location. This would reduce the need for individual shipments and onsite module reassembly.

The use of such structures could reduce the capital cost and minimize the projects' environmental footprint. Strategic optimization approaches have been used to evaluate possible design layouts for offshore container terminals from both technical and economic perspectives to minimize capital and operational costs (*Figure 5*).[144] Promising designs include offshore terminals based on floating platforms consisting of multiple interconnected modules, which could expand in capacity and size over time to respond to ongoing growth in demand.[145]

[142] Dongqi Jiang et al., "Behavior of concrete modular multi-purpose floating structures," *Ocean Engineering* 229 (2021).
[143] Joar Tistel et al., "Gravity Based Structure foundation design and optimization opportunities" (paper presented at the ISOPE International Ocean and Polar Engineering Conference, 2015).
[144] Alfred J Baird and Dirk Rother, "Technical and economic evaluation of the floating container storage and transhipment terminal (FCSTT)," *Transportation Research Part C: Emerging Technologies* 30 (2013).; Jelena Maletić, Lyudmila Prigoda, and Zoran Čekerevac, "Technical solutions and assessment of economic effects of construction of an offshore terminal," *Mechanics Transport Communications-Academic journal* 1597, no. 2018/3 (2018).
[145] Dimitris Souravlias et al., "Design framework for a modular floating container terminal," *Frontiers in Marine Science* 7 (2020).; Maarten Flikkema and Olaf Waals, "Space@ sea the floating solution," *Frontiers in Marine Science* 6 (2019).

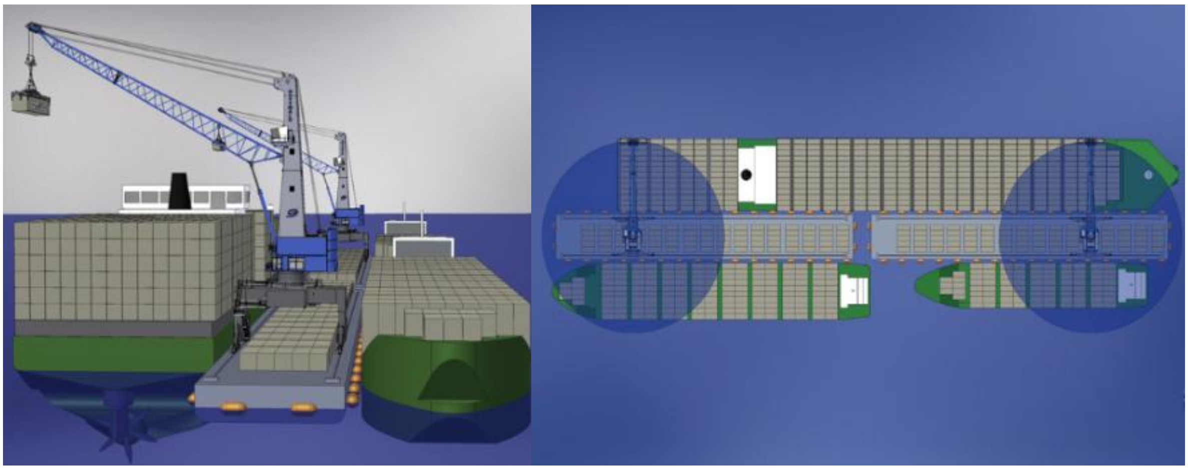

Figure 5: Floating Container Storage & Transshipment Terminal (FCSTT) design concept.[146] Cranes run on rails spanning the entire length of the terminal, enabling them to service vessels berthed alongside. The cranes' working range covers the full beam of ships docked on both sides.

7.5 Seaports as centres for the development of offshore wind power

Floating foundations could also support construction yards for various industrial activities. As discussed above, this is of particular importance to Norway, as many communities lack suitable land for expending port facilities and for new industrial activities. The physical characteristics of a given port limit what kinds of activities can be conducted in that port, and the construction of additional floating foundations can expand those activities. This is increasingly relevant as Norway is looking to offshore wind power to meet its decarbonization targets and future electricity needs. This includes decarbonizing operations on offshore oil and gas platforms by switching from gas turbines to wind turbines. Offshore wind parks on the Norwegian Continental Shelf (NCS) are expected to increase in number in the coming years. Norway's first floating offshore wind park, the Hywind Tampen, is located 140 km off the Norwegian coast in the North Sea and became operational in August 2023, generating an average of 88 MW.[147] The Norwegian government has set an ambitious goal of reaching 30 GW of offshore wind power capacity by 2040.[148] As an example, an offshore wind farm capable of generating 500 MW consists of about 35 wind turbines.

Norway wants to develop capacity along the whole supply chain for offshore floating wind parks -- including manufacturing, assembly, installation, operation, and maintenance. The manufacturing stage would, in the case of Norway, primarily include construction of large floating wind turbine foundations. Construction and assembly of wind turbine foundations requires large areas and port infrastructure adapted to the specific needs of the wind power industry. This applies in particular to floating wind turbines, as bottom-fixed wind turbines are assembled offshore at the selected location from large components shipped directly from

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[146] Alfred J Baird and Dirk Rother, see note 144 .
[147] Equinor, "Hywind Tampen," updated n.d., n.d., accessed 10.11, 2025, https://www.equinor.com/energy/hywind-tampen.
[148] Regjeringen, "Ambitious offshore wind initiative. ," ed. Office of the Prime Minister et al. (2022). https://www.regjeringen.no/en/whats-new/ambitious-offshore-wind-power-initiative/id2912297/.

foreign manufacturers (e.g., in Denmark, Germany, and China). Floating wind turbines require large areas for assembly that takes place either onshore (or close to shore) with access to deep-water quays, or offshore in deep, sheltered waters. Once assembled, the floating wind turbines are towed to the selected location for installation.

Today, several ports and shipyards along the Norwegian coast act as support and construction facilities for one-off oil and gas projects on the NCS.[149] This has enabled these ports to develop important experience in executing complex projects and constructing offshore structures. Many of the large oil and gas platforms on the NCS were assembled far inside the Norwegian fjords in deep sheltered waters, without any major infrastructure in the immediate vicinity. Similarly using the fjords for offshore wind power assembly could be a feasible and competitive approach.[150] Selected locations inside the fjords can also be used for storage during the winter, enabling year-round fabrication of wind turbine foundations and assembly.

Several Norwegian ports could serve as centres for logistics, operations, and maintenance of offshore wind parks. Smaller yards could complement the construction at larger yards by manufacturing smaller components. There is a need for a national framework for the development of the offshore wind industry so that investors can be confident that their infrastructure investments will be recouped.

7.6 Development of seaports as regional logistics clusters

Ports within the same geographical area would benefit from forming a cluster of logistics and economic activities.[151] Logistics clusters are places where various kinds of logistics activities can be found together. Sheffi (2012)[152] defines a logistics cluster as a region with a high concentration of logistics activities relative to the total population or economy. Such clusters are often seen as drivers of regional economic development, because ports attract a variety of economic activities and are increasingly measured in terms of added value rather than mere throughput.[153]

Several researchers have analysed the benefits of logistics clustering.[154] According to Blancas et al. (2022),[155] such clustering can improve logistics efficiency in several ways, via service specialization; supply-demand matching; sharing of equipment and infrastructure assets

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[149] Norsk Industri, *LEVERANSEMODELLER FOR HAVVIND - Delrapport – Norske havner, verft og byggesteder* (2021), https://www.norskindustri.no/dette-jobber-vi-med/energi-og-klima/fornybar-energi-til-havs/leveransemodeller-for-havvind/.
[150] Robert Hjorth et al., *Norway's 300 GW offshore wind opportunity*, Boston Consulting Group (2023), https://media-publications.bcg.com/norways-300-gw-offshore-wind-opportunity.pdf.
[151] Peter W. de Langen and Elvira Haezendonck, "Ports as Clusters of Economic Activities," in *The Blackwell Companion to Maritime Economics*, ed. Vayne K. Talley (Blackwell Publishing Ltd., 2012).; Teresa Verduzco-Garza and Aleu F Gonzalez, "Increasing competitiveness through a logistics and transportation cluster: A Literature Review" (paper presented at the Proceedings of the International Conference on Industrial Engineering and Operations Management, 2017).
[152] Yossi Sheffi, *Logistics clusters: delivering value and driving growth* (MIT press, 2012).
[153] Larissa M van der Lugt and Peter W de Langen, "The changing role of ports as locations for logistics activities," *Journal of International Logistics and Trade* 3, no. 2 (2005).
[154] Liliana Rivera, David Gligor, and Yossi Sheffi, "The benefits of logistics clustering," *International Journal of Physical Distribution & Logistics Management* 46, no. 3 (2016).; Myriam Liliana Rivera Virgüez, "Logistics clusters: Prevalence and impact" (Massachusetts Institute of Technology, 2014).
[155] Luis C Blancas et al., "Competing with Logistics Clusters: Vignettes from the International Experience," (2022).

across multiple users; multimodality; freight consolidation and deconsolidation; facilitation of backhauls; public-private partnerships; and collaboration between service providers and beneficial cargo owners. These logistics clusters can therefore become major drivers of increased productivity, environmental sustainability, resilience, and economic growth. They can also strengthen regional socio-economic development and value creation through economies of scale, increased scope of activities, and increased density and frequency of operations.

Several types of logistics clusters exist, which provide different opportunities for growth, as their objectives differ based on the type of industries, cargo flow, markets, and the types of stakeholders involved. Decisions regarding the design of clusters must always consider the overall needs, opportunities, and risks. The functionality of logistics clusters can also change over time, if, for example, certain industries in the region grow (e.g., predicted growth in the aquaculture industry in Norway) or decline, or if other clusters emerge. Blancas et al. (2022) also state that a limited number of integrated logistics centres (hubs) should form the core of any national logistics cluster strategy. These hubs should provide good connections and be integrated with a multimodal transport network and freight-related industries.

There are many small ports in Norway, typically close to one another and operating independently, which negatively impacts their profitability.[156] A disproportionate amount of money is currently being spent on developing ports located close to each other geographically, which require the same type of infrastructure and offer the same kinds of port services. This also requires shipping companies to call at several ports, transporting low cargo volume at each port at a high cost per unit, during times when freight rates could be very low. Greater cooperation between neighbouring ports and some mergers of ports would improve cost effectiveness; however, simply reducing the number of ports considerably without implementing any port infrastructure upgrades would affect the shipping industry negatively, as it would likely lose additional cargo volume to road transport. A benefit of the current system of many small ports is that it allows transport of cargo by sea as close as possible to customers and industries in remote locations.[157] This applies to mining, aquaculture, and fisheries. This is important, considering ongoing problems with the Norwegian road transportation system, particularly during the long winter months, and limited railway options. Easy port access is also important to regional socio-economic development in more remote locations as in Northern Norway, and for national security considerations.

Logistics cluster development must be based on market and demand considerations. The private sector typically plays a vital role, through public-private partnerships with the state and local governments, to ensure synergy and commercial cooperation. What is envisioned is a regional governance structure[158] led and owned by the state government, including representatives of municipalities and key logistics and industrial actors. Such a governance structure could better optimize the use of resources within each logistics cluster and therefore

[156] Svindland, Monios, and Hjelle, "Port rationalization and the evolution of regional port systems: the case of Norway."
[157] EM Marskar et al., *NTP Godsanalyse delrapport 1: Kartlegging og problemforståelse*, Avinor, Jernbaneverket, Kystverket, Statens Vegvesen (Oslo, 2015).
[158] Svindland, Monios, and Hjelle, see note 156.

maximize each region's potential, increase government investments in port infrastructure based on demand, and oversee the long-term development of the port system.

Some ports should be specialized, providing port services needed by specific industries and types of cargo. Within each logistics cluster, a central transshipment port (hub) would provide intermodal connections between sea, rail, and/or road, allowing easy access to the wider national and international transport networks. Domestic and international transport services within each logistics cluster would be managed from the regional hub through a hub-and-spoke system. This will lead to fewer but larger vessels calling at the main hubs, transporting greater volumes at lower unit costs, and enabling higher transport frequency between European ports and Norway, benefitting the competitiveness of Norwegian industry.

This strategy would avoid port closures (and the resistance that would bring) while enabling a more constructive way of organizing the port system through more specialization. Some European countries have already merged port authorities into regional governance models, so there is precedent for this approach. There have already been some mergers within the Norwegian port sector over the last decade,[159] but these have not resulted in specialization of ports. Most of the recent mergers seem to have had little effect on the distribution of cargo among terminals and ports, possibly since the mergers have not meant a centralization of ownership, as the newly merged entities typically are still owned jointly by the same owners that owned each port/terminal in the area.

This transition from municipal port to state ownership represents more than a mere administrative adjustment. The central management authority would be responsible for determining the specialization and development direction of each port based on the specific conditions of each logistics cluster, in order to avoid excessive regional competition. Future ambitions for a large transshipment hub serving the whole of Western Norway are still under discussion, with both Stavanger and Bergen as candidates.[160] As mentioned above, the poor condition of the road network along the western coastline is a limiting factor in this approach, making it more efficient to retain the existing ports for cargo deliveries; more extensive port consolidation would increase the need for road transportation. Consolidating cargo flows at one port in the region could gradually take place following extensive upgrades of the road and railway systems.

8. Conclusion

The seaport system in Northern Norway stands at a critical juncture, facing significant challenges but also holding significant potential. The region's geography and dispersed population have historically led to a decentralized system with numerous small ports. This

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[159] Else-Marie Marskar et al., *NTP Godsanalyse - DELRAPPORT 2: OFFENTLIGE GODSTERMINALER Struktur, eierskap, finansiering og drift*, Kystverket, Jernbaneverket, Kommunenes Sentralforbund and Statens vegvesen (2015), https://9pdf.net/document/yr3d6j6o-godsanalyse-delrapport-offentlige-godsterminaler-struktur-eierskap-finansiering-drift.html.
[160] Svindland, Monios, and Hjelle, see note 156.

structure provides necessary connectivity to remote communities and industries. However, it also presents considerable obstacles to efficiency and growth.

Key challenges identified include demographic decline; long shipping distances; limited state funding for maritime infrastructure; a fragmented governance model; low and imbalanced cargo volumes; and inadequate port facilities, particularly for intermodal transport. Although a shift toward maritime transport over road transport is a longstanding national policy goal, the reliance on road transport for high-value goods, such as fresh seafood, is difficult to relieve. This situation highlights the weak position the maritime sector holds today. However, these challenges can be resolved.

We have examined several forward-looking development strategies for seaports that can pave the way to a more sustainable and competitive future. Suggested development strategies include implementation of short-sea feeder networks (i.e., a hub-and-spoke model) which allows mother vessels to be bigger as they do not have to call at smaller ports, supporting economies of scale. This solution also offers a way to consolidate cargo and improve service frequency. This process may include ship-to-ship transshipment of containers at sea.

To support progress toward national and global sustainability goals, port owners can position their ports as decarbonization hubs by investing in onshore power supply (from renewable sources), offshore wind power, and alternative fuels. Furthermore, embracing smart port technologies can enhance operational efficiency, and innovative construction techniques, such as floating port infrastructure, could overcome physical land limitations.

We also propose a new governance model for seaports in Norway, moving away from the current model in which ports are owned and managed by several small municipal governments, toward a model of state ownership. State ownership of ports will strengthen national security and preparedness in an era of increased geopolitical tension in the High North. There is an urgent need to address the strategic importance of Northern Norway's seaports for national security and for both civilian and military preparedness. Under the Total Defense concept, these ports must be resilient enough to serve as critical lifelines for allied forces during geopolitical crises.

The development of regional logistics clusters will promote specialization and collaboration. By establishing regional state-owned ports, Northern Norway can optimize resource allocation; promote specialized port functions based on local industrial needs; and develop integrated hub-and-spoke transport systems. Such a transformation may enhance supply chain efficiency; bolster regional economic development; and increase the competitiveness of industries in Northern Norway.

Limitations of the study. The findings of this report must be interpreted within the context of several limitations. First, changes in the geopolitical landscape forced a fundamental adjustment to the project's original plan. The intended pan-Barents analysis became impossible due to the exclusion of Russian partners following the 2022 invasion of Ukraine. The authors thus removed the Eastern dimension of the study. This has meant the exclusion of the Northern Sea Route (NSR) and all potential trade flow with East Asian trading partners. The report thus presents a "Western Arctic" perspective, analysing Northern Norwegian ports in a state of geopolitical isolation that may not fully capture their long-term potential in a normalized trade environment.

Second, the drafting of this report began in early 2025. Because complete statistical data for 2024 were not yet available at the time, cargo throughput statistics from 2023 were used for analysis. Although the socio-economic shock of the Covid-19 pandemic had largely passed by 2023, global and regional supply chains were still undergoing a gradual process of recovery and stabilization. 2023 thus may not constitute a representative year.

Third, the reliance on semi-structured interviews unavoidably leads to subjectivity. Stakeholders in the maritime sector operate in a competitive environment and often tend to highlight their strengths rather than disclose their weaknesses. Port authorities, for example, have an incentive to emphasize their development potential and strategic locations to attract public funding, potentially downplaying internal inefficiencies. This report attempts to mitigate this through triangulation with statistical data, but for forward-looking topics—such as "port development potential" or the feasibility of "autonomous feeder networks"—there is no statistical baseline to check against.

9. Recommendations

Based on the conclusions above, this section presents a set of strategic recommendations designed to guide policymakers, port authorities, and private sector stakeholders in the creation of a more efficient, sustainable, and competitive seaport system in Northern Norway.

1. Revise the port governance model. Initiate a transition from the current decentralized, municipality-owned port system to a model of state-owned ports and regional logistics clusters. This new governance structure should be supported by the Norwegian government to ensure alignment with national transport strategies and to facilitate strategic long-term investments.

2. Increase and target funding. Reevaluate the allocation of funds within the National Transport Plan to significantly increase investment in maritime infrastructure, particularly in Northern Norway. Funding should be prioritized for projects that enhance intermodal connectivity; develop regional logistics hubs; support the green transition (e.g., onshore power supply, alternative fuel infrastructure); and explore innovative construction techniques such as floating port infrastructure to overcome land scarcity.

3. Strengthen modal shift incentives. Reform the current subsidy mechanisms to more effectively incentivize a cargo shift from road to sea. This could include schemes that support the establishment of new feeder shipping routes; financial support for new logistics solutions utilizing sea transport; and funding for technologies that make sea transport viable for time-sensitive goods (e.g., super-cooling for seafood).

4. Develop a national framework for offshore wind. Establish a clear national strategy for the development of offshore wind power generation that defines the role of Norwegian ports in the supply chain. This will provide confidence for ports and private companies, making them more likely to invest in the necessary infrastructure for manufacturing, assembly, and maintenance activities.

5. Pursue collaboration and specialization. Actively develop partnerships between neighbouring ports to form regional logistics clusters. Ports should develop specialized roles based on their unique strengths, geographical locations, and proximity to key industries (e.g., one port focusing on container traffic, another on bulk commodities, and another on services for the aquaculture industry).

6. Adopt digitalization and smart technologies. Invest in smart port solutions to improve operational efficiency and national security. This includes real-time information sharing; improving cargo handling; utilizing data analytics to optimize vessel turnaround times and resource allocation; and ensuring digital systems are resilient against cybersecurity threats.

7. Active managers of regional supply chains. Port owners should become proactive development agents by transitioning from passive landlords to active managers of the regional supply chain. Port owners should engage directly with cargo owners and logistics services providers to understand their needs, identify bottlenecks, and co-develop more efficient and cost-effective transport solutions.

8. Plan for the energy transition. Ports should develop clear roadmaps for becoming decarbonization hubs. This involves installing onshore power supply systems, providing alternative fuels like hydrogen or ammonia, and collaborating with local energy producers and industries to create integrated energy systems.

9. Collaborate to consolidate cargo. Cargo owners and third-party logistics providers should explore opportunities for joint procurement of transport services to consolidate cargo. This would create the necessary scale to attract more frequent and cost-effective shipping services, reducing reliance on road transport.

10. Invest in feeder network solutions. Shipping companies, in partnership with other logistics providers, should analyse the feasibility of establishing hub-and-spoke feeder networks in Northern Norway. This could involve smaller, more flexible vessels (including autonomous and/or low-emission ships) distributing cargo between a central regional hub and smaller ports nearby.

11. Engage with port organizations on infrastructure needs. Proactively communicate with port owners about specific infrastructure requirements that would facilitate a modal shift. These could include, for example, refrigerated container storage, ship-to-ship transshipment facilities, efficient ship-to-rail transfer facilities, and value-added port services (e.g., packaging, labelling). Invest in and adopt technologies that can extend the shelf-life of perishable goods like fresh seafood, for which advances in packaging and cooling technology could make sea transport a viable option.

12. Integrate national security concerns into port planning. In alignment with the Total Defense concept, port upgrades should ensure that digital and physical infrastructure can accommodate both commercial cargo and military logistics needs during times of crisis.