

Governing maritime safety in a crowded sea

A multi-layer framework for integrating shipping safety into offshore wind planning in the Netherlands and the United Kingdom

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A multi-layer framework for integrating
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the Netherlands and the United Kingdom

by

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Preface

This thesis marks the completion of my MSc in Complex Systems Engineering & Management (CoSEM) at Delft University of Technology, with a specialisation in Energy & Industry. Over the past seven months, I have worked at the intersection of offshore renewable energy and maritime safety. I chose a topic that matched my strong interest in the offshore energy sector, while stepping into the maritime domain, which was largely new to me. That combination proved to be both challenging and rewarding. During this research, I gained a deeper appreciation that the energy transition is not only a matter of scaling up technology and capacity, but also depends on governance, safety and the many interdependent systems that shape how offshore wind can responsibly expand.

I would like to express my sincere gratitude to my thesis committee: Dr. A. F. Correljé and Dr. M. Yang from TU Delft, and Dr. A. Boersma-Willkomm from the Ministry of Infrastructure and Water Management. First, I would like to thank Dr. A. F. Correljé for his constructive supervision and guidance throughout the thesis process. His feedback helped me structure this complex problem, sharpen the scope of the research and build a clearer narrative. He consistently provided thoughtful feedback on both content and argumentation, shared relevant literature at key moments and was always quick to respond when I had questions. His support was very important in keeping the project focused and academically grounded.

I am also grateful to Dr. M. Yang for his valuable safety-management perspective and critical insights. His feedback played an important role in shaping the framework and in connecting the different governance and safety layers that this research builds on. Our meetings helped me translate safety theory into an approach that could be applied to offshore wind planning in practice and his questions pushed me to dive deeper into safety theory.

Finally, I would like to thank Dr. A. Boersma-Willkomm and the wider team at the Ministry of Infrastructure and Water Management for enabling this project and for sharing their time and expertise. Our weekly meetings offered a unique insight into the real-world challenges that come with scaling offshore wind in a crowded sea space. I am grateful for the openness with which he shared experiences, considerations and ongoing work. The opportunity to conduct this research in close connection with practice has been both inspiring and formative and it strongly shaped how I approached the relevance and implications of this thesis.

I also want to thank my parents for their support throughout the past years. This academic journey has been a long ride, and I know there were moments when it may have felt like it would never end. Your encouragement, patience and belief in me have made all the difference. I would not have been able to develop the experience and opportunities I have today.

Finally, I would like to thank my study friends. We spent countless hours together working on projects, studying and laughing along the way. This thesis, and the broader academic journey behind it, would not have been the same without them. In many ways, this work also reflects the shared effort, energy and support we gave each other throughout the programme.

Looking back, the experience of the last months has only made me more excited about what comes next. With this thesis, I close an important chapter and I look forward to taking the lessons learned into the next step of my path.

*Jelmer Merkus
Delft, March 2026*

Summary

Offshore wind expansion in the North Sea is accelerating, but at the same time intensifying pressure on maritime safety in one of the world's busiest sea areas. As the number of fixed infrastructure installations and amount of new service traffic increases, ships face reduced manoeuvring space, more non-route-bound vessel movements and higher collision and disruption risk. The 2022 incident in which a drifting cargo vessel collided with the foundation of a Dutch offshore wind farm made these risks visible and reinforced warnings that safety is too often integrated late, while cumulative and cross-border effects remain insufficiently understood. Because risks cross national borders, relying on isolated national measures is insufficient.

This thesis explains how shipping safety becomes integrated in offshore wind planning as the sector scales up and why broadly similar North Sea conditions can still produce different safety integration outcomes. It compares the Netherlands and the United Kingdom, two mature offshore wind contexts with similar geography but different governance arrangements, to identify where safety influence enters the decision chain, when choices become hard to reverse and which capabilities are needed to keep safety credible as density increases.

The main research question of this thesis is the following:

"How do vertical coordination, horizontal coordination, Safety-I/Safety-II approaches and compliance design shape the integration of shipping safety into offshore wind planning in the Netherlands and the United Kingdom as offshore wind scales up?"

The research uses a comparative case study design based on document analysis and expert interviews. It applies an integrated analytical framework combining four dimensions: vertical allocation of responsibilities across levels, horizontal coordination between sectors, safety mode (Safety-I compliance vs Safety-II anticipatory learning) and a dual-layer compliance structure (prescriptive baselines plus performance-based proof). The comparison focuses on how these layers align over time and how alignment affects when safety constraints become binding.

Both countries integrate navigational safety through a multi-stage governance funnel. Strategic spatial steering narrows options, project-level assessment generates evidence and consenting translates evidence into binding conditions and operational agreements. The crucial difference is where in that process safety alignment is stored: upstream through plan-led boundary-setting (NL) versus more downstream through evidence-led consenting and the formal consent record (UK). This difference influences when safety concerns must be raised to remain influential, who carries the burden of proof and where delay or redesign risk concentrates.

Main findings:

- **Netherlands: upstream stabilisation through plan-led steering.**
In the Dutch system, shipping safety is stabilised relatively early through central marine spatial planning and state-led site preparation. International baselines and safety principles are translated into binding boundary conditions upstream (e.g., spatial choices, corridors and minimum requirements) before tendering. This pushes the most consequential trade-offs to earlier stages and reduces late-stage surprises, because later project development needs to happen within a pre-specified scope.
- **United Kingdom: downstream stabilisation through developer-led proof in consenting.**
In the United Kingdom, early screening exists (through leasing-stage processes), but many safety issues are resolved later through Navigational Risk Assessments and evidence in the consenting record. Maritime safety influence is exercised mainly through consultation, recommendations and how defensible evidence is documented for inspectors and decision-makers. This preserves flexibility but increases vulnerability to late lock-in, evidence conflicts and costly redesign

once projects are commercially committed. The United Kingdom is increasingly strengthening upstream screening during leasing (through more structured assessments and earlier consultation) to decrease risk of delay or denial of projects for developers. Yet, the decisive safety proof and binding conditions largely remain concentrated in the consenting phase.

- **Decision power does not remove evidence need, it changes how it works.**

Across both cases, safety influence depends on quantified, traceable and defensible evidence, either because maritime authorities lack a formal veto (UK) or because upstream constraints must still be justified as proportionate and reasonable (NL). In practice, evidence quality and shared assumptions become a governance resource. They determine whether safety concerns translate into enforceable requirements instead of remaining advisory.

- **Safety-I remains the baseline (minimum norms/limits), while Safety-II is emerging as an evidence-building capability as density grows.**

Compliance-oriented Safety-I provides non-negotiable minimum requirements and supports legal accountability. However, as sea space becomes denser and risks become more cumulative and system-wide, Safety-II can become increasingly important for justifying preventive action before major accidents occur. Scenario modelling, indicators, near-miss learning and structured learning loops function as an evidence-production capability. They make emerging and cumulative risks visible and provide defensible, forward-looking arguments that help maritime safety actors justify measures in a polycentric system where they compete with other users for the same sea space.

- **Both systems rely on a dual-layer compliance structure, while the performance layer grows in importance.**

In both countries, the minimum demands are produced through a prescriptive baseline, complemented by a performance-based layer requiring site-specific proof that residual risk is acceptable. As straightforward avoidance of risks becomes less feasible in a dense sea space, more decisions shift into this performance layer. Dual-layer compliance remains robust only if there is sufficient review capacity, consistent methods and shared data baselines to evaluate deviations from prescriptive rules.

Implications for practice: what to strengthen now

The comparison shows that the central challenge is not choosing one instrument (planning, NRA or standards), but ensuring alignment between upstream steering, coordination capacity, evidence quality and learning mechanisms. Based on the cross-case findings, four actions directly strengthen navigational safety governance as offshore wind scales:

- **Institutionalise anticipatory evidence production (Safety-II).**

Implement routine scenario-based reviews, near-miss learning and structured learning loops into planning cycles so anticipatory capacity persists beyond incident-driven attention.

- **Strengthen upstream screening where it has highest impact.**

Use early engagement with shipping and other users to exclude or re-design high-conflict areas before commercial and procedural lock-in increases.

- **Invest in review capacity and consistency.**

Ensure regulators/inspectors have the expertise and resources to challenge assessments and to evaluate deviations from prescriptive baselines consistently and transparently.

- **Maintain a shared evidence base.**

Build shared datasets and operational parameters between departments (traffic patterns, manoeuvring needs, routes, port practices, projections) so cumulative interactions can be assessed with similar inputs across projects and institutions.

This thesis contributes to literature by showing that offshore wind shipping safety outcomes are shaped by the interaction of four governance layers that are often studied separately. Multi-level governance, polycentric governance, safety paradigms (Safety-I/Safety-II) and compliance design. Rather than analysing these dimensions in isolation, the thesis integrates them into one analytical framework and demonstrates empirically how their interaction produces different safety integration outcomes. A key conceptual insight is that more alignment is not always better. What matters is where alignment is stored in the governance chain (upstream vs downstream), because this shifts where uncertainty, conflict and capacity bottlenecks appear.

Both the Netherlands and the United Kingdom integrate maritime safety in offshore wind expansion, but they do so through different governance logics that place pressure on different parts of the system. As offshore wind scales and space becomes more congested, maintaining acceptable safety increasingly depends on shared evidence infrastructure, assessment and study capacity and institutionalised learning, so that governance can anticipate cumulative risk rather than waiting for serious accidents to force change.

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Abbreviations

Abbreviation	Definition
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
CoSEM	Complex Systems Engineering & Management
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ERTV	Emergency Response Towing Vessel
FSA	Formal Safety Assessment (IMO)
LCOE	Levelized Cost of Energy
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MMO	Marine Management Organisation
MOSWOZ	Scheepvaartveiligheid (MOSWOZ; used in Dutch North Sea policy context)
NRA	Navigational Risk Assessment
NSIP	Nationally Significant Infrastructure Project
OREI	Offshore Renewable Energy Installation
OVV	Onderzoeksraad voor Veiligheid
OWF	Offshore Wind Farm
PDA	Project Development Area
SAR	Search and Rescue
SEA	Strategic Environmental Assessment
Safety-I	Safety paradigm focused on preventing things from going wrong
Safety-II	Safety paradigm focused on ensuring things go right (resilience/adaptation)
TCE	The Crown Estate
UKHO	UK Hydrographic Office

1

Introduction

This chapter introduces the governance challenge of integrating shipping safety into offshore wind planning. It explains the societal and policy relevance, identifies the academic and practical knowledge gap and formulates the research questions. The chapter then closes with a structure of the thesis.

1.1. Problem formulation

The urgency of the climate crisis and the geopolitical need to reduce dependence on fossil fuels have accelerated the push toward renewable energy. In Europe, offshore wind energy has emerged as one of the most important energy sources in the energy transition, with the North Sea seen as one of the most promising areas for large-scale development. The European Union has set the target of installing at least 300 GW of offshore wind capacity by 2050. In addition, through the 2023 Ostend Declaration, 9 countries in North-West Europe, including the Netherlands, have committed to making the North Sea the “green power plant of Europe,” with 120 GW by 2030 and 300 GW by 2050 [14].

However, the North Sea is already one of the world’s busiest maritime areas, where shipping, fishing, defense, nature protection and offshore energy must coexist. The rapid expansion of offshore wind farms transforms this environment into a dense, multi-use hub and introduces new and complex safety challenges. These challenges are not limited to preventing collisions or accidents. They concern the ability of the maritime system to operate safely under dynamic, uncertain and interdependent conditions. Importantly, this is not only a well-known policy issue with a mature playbook. Offshore wind scale-up creates a governance and safety context that is still new for policymakers and regulators. Decisions must be made under rapid change, interdependence and limited historical examples.

While offshore wind expansion is crucial for achieving EU’s ambitious energy and climate targets for 2030 and 2050, it creates serious spatial and safety challenges. The construction of large-scale offshore wind farms reduces manoeuvring space for vessels, alters existing traffic routes and complicates navigation in one of the world’s busiest seas. Construction and maintenance of wind farms also results in more small and fast service vessels, which do not stick to traditional routes. These pressures are not only theoretical: in January 2022, the bulk carrier *Julietta D* lost its anchor during a storm and began drifting near IJmuiden, where it first collided with another tanker. As it drifted further, it struck a foundation of the under-construction *Hollandse Kust Zuid* wind farm. Rescue operations prevented grounding and injuries of the crew, but the damage to windfarm infrastructure and risk to crew were substantial [12]. This incident highlights the growing risks of operating in increasingly congested maritime space. It showed the vulnerability of critical energy infrastructure, raising urgent questions about the adequacy of current shipping safety governance.

The Dutch Safety Board (Onderzoeksraad voor Veiligheid (OVV)) has emphasized these challenges in its 2023 report *Navigating the Space* (“Schipperen met de ruimte”). The report warns that spatial planning at sea is largely driven by energy ambitions, while shipping safety considerations are often integrated too late or only partially. As a result, the safety goal for the North Sea “maintain shipping safety at least at current levels, or ideally improve it, even as fixed objects multiply” might not be re-

alistic in the near future. The Dutch Safety Board further stresses that safety risks in the North Sea are increasingly transboundary, making unilateral national approaches insufficient [51]. Furthermore, the Dutch Safety Board states that the Dutch government lacks sufficient insight into how risk factors interact and what the cumulative effects of spatial pressure are. This makes it difficult to judge whether proposed measures will actually reduce incident risk, which might create a false sense of security [51].

The current approach to shipping safety mainly focuses on avoiding accidents, ensuring compliance with regulations and responding after incidents occur [5]. While this reactive model has worked well for conventional shipping, it is less suitable for the complex and fast-changing environment around offshore wind farms, where risks develop quickly and responsibilities are shared across many actors and countries. To ensure safe operations in such a system, safety management needs to move beyond preventing failures toward actively creating the conditions for safe performance. This means focusing more on how different stakeholders and systems can anticipate risks, adapt to change and maintain reliable operations under changing circumstances. Such a shift requires a more proactive, flexible and collaborative approach to safety governance, better aligned with the distributed and dynamic nature of the North Sea [15].

This situation creates a governance dilemma. On the one hand, the offshore wind farms on the North Sea seem to be essential for Europe's renewable energy system. On the other, shipping safety must be safeguarded to protect human lives, environmental protection and critical infrastructure. Governance on the North Sea is complex due to the authority of organisations on multiple levels and different sectors (energy vs. maritime), often leading to inconsistent safety standards, limited coordination and gaps in risk management [64].

These developments show that the challenge is not only technical but also about how safety is governed. This thesis therefore examines how shipping safety becomes embedded in offshore wind planning as offshore wind scales up and why similar North Sea conditions can still lead to different safety outcomes.

The problem at the base of this thesis is therefore the tension between the urgent need for offshore renewable energy expansion and the equally important need to ensure safety. This tension is strengthened by recent accidents, warnings from safety authorities and the complexity of multi-level and cross-sector governance in this problem. At the same time, countries facing broadly similar North Sea conditions appear to adopt different safety measures. This suggests that differences in coordination and policy-making dynamics may help explain variation in outcomes.

Existing work often addresses offshore wind governance through one lens at a time: Multi-level coordination, cross-sector coordination or safety governance. It pays less attention to how these dynamics interact in shaping safety measures. This fragmentation leaves a gap in understanding not just why approaches differ, but how to design governance that effectively handles the conflicting pressures of energy scaling and shipping safety in the North Sea. Empirically, this thesis is built on access to policy practice during the internship, including the opportunity to observe coordination moments and decision dynamics from a relatively independent position. This complements interviews and document analysis by showing how safety concerns and evidence travel through real planning interactions.

The objective of this thesis is to design a multi-layer governance framework that identifies where and how safety governance must be integrated in the planning of offshore wind to remain effective. To achieve this, the thesis develops a multi-layer governance framework focusing on vertical coordination across levels, horizontal coordination between sectors, safety logic (Safety-I vs Safety-II) and how oversight is organised. The framework is applied in a comparative case study of the Netherlands and the United Kingdom. By analysing these two systems, the research does not only explain why similar North Sea conditions can still lead to different safety measures and trade-offs, but derives design principles for balancing upstream spatial steering with downstream flexibility as offshore wind scales up. In this thesis, 'upstream' refers to earlier stages in the planning chain, while 'downstream' refers to later stages.

1.2. Link to the MSc Complex Systems Engineering & Management programme

The Master's program in Complex Systems Engineering & Management at Delft University of Technology focuses on understanding and designing large-scale socio-technical challenges that involve many actors, interdependent systems and conflicting interests [36]. The governance of offshore wind energy in the North Sea is such a challenge. It requires balancing the urgent demand for renewable energy with the equal need for shipping safety in one of the world's busiest sea regions. This issue transcends national borders and involves governments, international organisations, industry and market. Moreover, an extremely complex infrastructure is developing in the North Sea, not only in terms of technical installations, such as offshore wind farms and subsea cables, but also regarding its scale and the critical safety challenges this expansion brings. Addressing this issue requires a multidisciplinary approach that involves policy analysis, risk management and institutional design. Thus, the topic represents a complex systems problem of high relevance, making it a strong fit with the focus of the CoSEM program.

This thesis contributes in a way that aligns with CoSEM's design and engineering focus by developing and applying a multi-layer governance framework that structures how shipping safety becomes integrated in offshore wind planning. The framework is used to analyse coordination mechanisms across governance levels and sectors and show how safety can be integrated earlier and more consistently while balancing public values (safety, environment, reliable energy supply) and private values (project feasibility, costs and timelines).

1.3. Research questions

To analyse the challenges of safeguarding shipping safety while rapidly expanding offshore wind energy, this thesis treats the integration of shipping safety as a governance outcome. It means how and when shipping safety considerations shape offshore wind planning processes and the resulting measures (e.g., spatial constraints, monitoring and emergency response arrangements). This integration is examined through four aspects reflected in the research questions: vertical coordination across governance levels, horizontal coordination between sectors, the timing and safety logic (Safety-I vs Safety-II) and how compliance/oversight is operationalised in practice.

In this thesis, "offshore wind planning" refers to the full decision chain from strategic area/site selection (e.g., marine spatial planning and/or seabed leasing) through project-level assessment and consenting procedures. The objective of this thesis is to explain variation in how shipping safety is integrated into offshore wind planning by analysing governance coordination and safety logics in two North Sea cases.

This leads to the following main research question:

"How do vertical coordination, horizontal coordination, Safety-I/Safety-II approaches and compliance design shape the integration of shipping safety into offshore wind planning in the Netherlands and the United Kingdom as offshore wind scales up?"

To answer this question, the thesis focuses on two countries (the Netherlands and the United Kingdom) in the scaling phase of offshore wind development that share similar geographical and energy ambitions, but show notable differences in safety measures. The answer to the main research question, the following sub-questions are formulated:

1. *How are responsibilities and safety requirements coordinated across governance levels (international, national, regional), and how has the delegation of responsibility evolved over time?*
2. *How do formal and informal coordination mechanisms structure interactions between sectors in offshore wind planning, and how does sectoral influence shape safety-related trade-offs?*
3. *How and when does shipping safety enter the offshore wind planning process, and to what extent is safety governed through a Safety-I (reactive, compliance-driven) versus Safety-II (proactive, adaptive, learning-oriented) logic?*
4. *How is compliance with shipping safety ensured in practice through a dual-layer structure (a prescriptive baseline plus performance-based oversight)?*

Together, these sub-questions enable a structured comparison of how shipping safety becomes integrated in offshore wind governance. It shows how differences in coordination and policy-making dynamics result in different safety outcomes across countries/cases.

1.4. Report structure

The thesis is structured as follows. Chapter 2 develops the theoretical foundation by reviewing multi-level governance, polycentric governance and safety literature. Combining these concepts gives the analytical framework for studying the integration of shipping safety into offshore wind planning.

Chapter 3 builds the analytical framework used for studying shipping safety in offshore wind governance. It explains how multi-level governance, polycentric governance, Safety-I/Safety-II and the safety perspectives are merged, then translates them into analytical dimensions used to analyse the Netherlands and UK cases.

Chapter 4 explains the research methodology. It includes the comparative case study design, data collection through document analysis and interviews and the operationalisation of the analytical framework.

Chapters 5 and chapter 6 present the empirical case studies of the Netherlands and the United Kingdom. Each chapter first describes the process of planning and the safety measures implemented in offshore wind planning and then explains these outcomes using the analytical dimensions.

Chapter 7 compares the two cases to identify how differences in coordination mechanisms and policy-making dynamics shape the integration of shipping safety into offshore wind governance.

Chapter 8 concludes the thesis by summarising the main findings and giving the conclusions. It also discusses what the thesis adds to literature and what experts and regulators, not only from the Netherlands and the United Kingdom, but also from other countries can learn from the research. It ends with limitations to the research and potential for future research.

2

Theoretical Foundations: Governance and Safety in Offshore Wind

This chapter develops the theoretical foundations in line with the analytical dimensions introduced in Chapter 1. It describes the integration of shipping safety into offshore wind planning as a process shaped by vertical coordination across governance levels, horizontal coordination and sectoral influence, the timing and mode of safety integration (Safety-I vs Safety-II) and a dual-layer compliance structure combining a prescriptive baseline with performance-based targets.

To understand these dimensions, the chapter uses multi-level governance (MLG), polycentric governance and safety governance literature. MLG explains how authority and responsibilities are distributed and aligned across international, national and regional levels. Polycentric governance explains how multiple sectoral actors coordinate and compete in shared maritime space. Safety governance explains whether safety is integrated late and reactively through prescriptive compliance or early and proactively through adaptive, learning-oriented systems. Finally, the dual-layer compliance dimension specifies how safety requirements become enforceable in practice through minimum rules and evidence-based oversight.

In this chapter, multi-level governance is used to explain vertical coordination across governance levels and polycentric governance to explain horizontal/sectoral coordination. Safety-I/Safety-II is used to analyse the timing and logic of safety integration.

2.1. Multi-level governance

2.1.1. Definition and origins

To understand how energy sources are governed, it is important to define the concepts of energy governance and multi-level governance. According to Moghani and Loni [35], energy governance refers to a framework of rules and institutions that manage the production, distribution and consumption of energy resources. It involves decision-making processes that balance economic, social and environmental goals, while adapting to complexities and uncertainties. In recent decades, governance has shifted towards more decentralised and interdependent forms of decision-making. This includes the rise of multi-level and polycentric governance, where authority is shared among local, national and international actors. These approaches encourage cooperation between different groups and organisations, allowing decision-making to be shared across several levels of government and institutions.

The concept of multi-level governance emerged in the 1990s within European integration studies as a way to describe the changing nature of authority in the European Union [20]. It challenges the traditional state-centric view that governance is organised hierarchically, with clear lines of command between central and local governments. Instead, MLG describes that decision-making authority is spread across multiple levels of governance, including international, national, regional and local arenas. Actors at these levels are interdependent and engage in continuous negotiation rather than top-down hierarchies.

Nunan [40] defines multi-level governance as a governance system where multiple actors operate at different levels (local, national, international), each with their own roles, interests and institutions, interacting both vertically and horizontally. A framework or guide for analysing MLG focusses on three main areas:

- Multiplicity of levels, actors and institutions
- Vertical and horizontal interactions
- Governance performance

Applied to energy policy, MLG shows how authority over the energy transition is distributed vertically among international, regional and national levels. International climate agreements, European directives and national implementation plans are interdependent in complex ways. This vertical interdependence shapes how decisions are made, resources are allocated and accountability is structured. In complex energy systems, such as electricity networks or hydrogen markets, no single level of a government has complete control. Coordination instead relies on negotiation, policy alignment and information exchange across levels rather than enforcement by a single authority. In this thesis, alignment means that responsibilities, decision criteria and evidence expectations are made mutually across governance levels and arenas, so they consistently guide decisions. A full definition is provided in Section 3.2.

2.1.2. MLG in other complex energy systems

The analytical value of MLG frameworks has been demonstrated in other complex energy systems. One of the most established applications is European electricity-market integration [25]. EU legislation (e.g., rules on cross-border trade and network codes) is translated into national regulation and implemented by national regulators. EU rule-making and national implementation, has been crucial to transform electricity systems into a Europe-wide market. However, this also reveals a typical constraint of MLG: EU-level authorities such as ACER facilitate cooperation but rely on Member States for enforcement, creating gaps when national and international priorities diverge [2]. A similar pattern is visible in the emerging hydrogen economy, in which the European Hydrogen Strategy provides direction at the EU level while national and regional actors experiment with implementation mechanisms.

An additional illustration of MLG limitations comes from Swedish water governance [41]. This system involves multiple public and private actors across local, regional, national and EU levels, leading to broad stakeholder involvement. At the same time, it reveals how unclear responsibilities and fragmented knowledge across levels can undermine oversight. In this case it resulted in reactive governance and weak feedback loops for learning and improvement over time [41].

2.1.3. Strengths and limitations

Multi-level governance offers important advantages in managing complex systems by enabling coordination across local, regional, national and international levels. The involvement of multiple actors can enhance adaptability, stakeholder engagement and alignment of goals across sectors. In Swedish water governance, for instance, a broad network of public authorities, municipalities and civic associations collaborate across administrative levels to manage water resources. This system benefits from a high degree of openness, transparency and decentralised participation, which strengthens adaptive capacity and promotes information exchange [41].

However, MLG also presents key limitations. The fragmentation of responsibilities and lack of clear coordination can lead to confusion, inefficiencies and delayed responses. In the Swedish case, weak feedback mechanisms and overlapping responsibilities hinder institutional learning and long-term adaptation, particularly in addressing cross-scale challenges like climate change and water quality [41].

Taken together, these examples show that MLG can enhance alignment, participation and adaptability across levels of governance, but can also risk fragmentation, unclear mandates and slow responses when responsibilities overlap. This is directly relevant to offshore wind governance and maritime safety. Vertical interactions between the IMO, EU institutions, national ministries and regional authorities determine not only who has authority over safety, but also when safety enters the planning process. If coordination across levels is weak or delayed, safety considerations may appear only after spatial and economic decisions have already been made, reinforcing a reactive rather than proactive approach to safety.

2.2. Polycentric governance

2.2.1. Definition and principles

Ostrom [42] defines polycentric governance as a governance structure that involves multiple centers of decision-making that are formally independent yet interact within a system of general rules. The idea contrasts with monocentric systems, where a single authority is dominant. Polycentric systems enable a decentralised approach, where decision-makers operate independently but in interaction with one another. Polycentric governance has mainly been used to analyse management of common goods. Batalden and Sydnes [5] define polycentric governance as “a situation where different actors regularly arrive at mutually satisfactory and binding decisions by negotiating and deliberating with each other and co-operating in the implementation of these decisions, without any of these actors being able to impose a decision on the others”.

They build on earlier work by Sovacool and Ostrom’s polycentric governance framework to identify six variables that form effective climate and energy governance. These variables, organisational multiplicity, experimentation and flexibility, ownership and accountability, equity and co-benefits, inclusivity and local involvement and information, demonstration and innovation, capture how complex governance systems can promote adaptability, fairness and innovation. Together, these dimensions provide an operationalisation of polycentric governance, showing the institutional diversity and social inclusion necessary for resilient and effective climate and energy transitions.

2.2.2. PG in other Complex energy systems

An example of polycentric governance is visible in German onshore wind energy, where multiple decision-making centres operate at federal, regional and local levels and interact with public, civil and private actors [6]. These centres influence one another through negotiation, legislation and planning processes. This created a flexible but potentially fragmented governance landscape. The German federal structure supports experimentation and learning across levels, while regional planning mediates between national targets and local acceptance. However, coordination ambiguities across levels can lead to delays, overlapping responsibilities can reduce accountability and system complexity can make strategic alignment and change difficult.

2.2.3. Strengths and boundaries

According to Carlisle and Gruby [8], polycentric governance adds a more flexible and adaptive characteristic to decision-making in complex energy systems. Polycentric governance improves institutional fit by aligning governance decisions with ecological and social interests through multiple, overlapping decision-making centers operating at different levels. This allows rules and strategies to be tailored to specific contexts while maintaining coordination across borders. It also strengthens adaptive capacity by enabling experimentation, learning and innovation across governance layers and departments. This way it allows institutions to adjust as technologies, environmental conditions and social needs change. Finally, polycentric governance improves risk mitigation through redundancy, as overlapping authorities and diverse institutions are safeguards against policy or institutional failure, ensuring that no single point of failure can damage the entire system [8]. While polycentric governance structures offer important strengths in managing complex energy systems, they also present limitations that need to be considered. These limitations often arise from the same characteristics that make such governance systems flexible and inclusive, the spreading of authority across numerous actors and decision-making levels.

Research highlights the tension between complexity and effectiveness. On one hand, involving more actors and levels in a governance process may improve coordination, adaptability and learning, as multiple stakeholders can experiment with different approaches and learn from each other. These different perspectives also enable the integration of local or specific knowledge. This could improve the fit of policies. In addition, overlapping institutions can create redundancy and reduce the risk of big failures if one actor or policy fails, because no single breakdown undermines the whole system [3]. Newig and Fritsch [38] also showed a strong positive correlation between the number of governance levels involved and the quality of environmental outputs. The number of agencies participating also showed a positive correlation to policy outcomes.

However, same multiplicity of actors that can improve learning and flexibility can lead to fragmenta-

tion, high coordination costs and delays in implementation. Power imbalances may allow stronger institutions to dominate decisions and unclear roles or overlapping mandates can cause confusion and inefficiency. Although actors monitor each other, accountability mechanisms are not always sufficient to prevent delays or coordination problems [3].

2.2.4. Informal coordination and sectoral influence

Polycentric governance is not only characterised by multiple centres of authority, but also by the fact that policy outcomes are shaped across different decision arenas [42]. Besides formal procedures (consultations, mandatory assessments, permitting steps), coordination often happens through informal arenas such as working groups, bilateral alignments, expert networks and recurring inter-departmental meetings.

From a systems engineering perspective, these informal arenas serve a critical design function. They act as feedback loops that bypass the slower formal regulatory procedures. Formal decision cycles, such as statutory consultation periods or legislative updates, often operate on time scales of months or years. In contrast, the technical risks of offshore wind (e.g., turbine scaling, vessel traffic density) evolve rapidly. Relying solely on formal channels creates regulatory delays, where safety signals arrive too late to influence design choices.

In these settings, stakeholders can exchange information, test positions and reach pre-agreements before decisions are formalised. As a result, formal decision moments may primarily serve to legitimise and record choices that were already shaped earlier.

In such arenas, the question is not only whether coordination exists, but how sectoral influence shapes trade-offs. Three influence mechanisms are especially relevant [16]:

1. Actors can shape outcomes through control over expertise and data, affecting what counts as credible evidence of risk and which solutions are seen as feasible.
2. Actors influence outcomes through agenda-setting and timing, by pushing safety concerns early (as a design constraint) or later (as mitigation after key choices are settled).
3. Influence can arise from network position and convening power. Actors who consistently participate, set meetings, or act as gatekeepers can steer which perspectives are included, even without formal authority.

Chapter 3 translates these dynamics into empirical indicators, such as which arenas exist, who convenes and participates consistently and who controls or validates key evidence in decision-making [16].

2.2.5. Implications for offshore wind and safety

Polycentric governance is highly relevant for offshore wind and maritime safety because it highlights the challenge of coordinating multiple sectors, energy, shipping, defense, fisheries, environmental authorities and port authorities. None of them can impose decisions on each other. Overlapping mandates can enable innovation and flexibility, but they can also lead to uncertainty over who is responsible for maritime safety measures, when safety actors are involved and how information is shared across sectors. These characteristics help explain why safety may become integrated early and proactively in some offshore wind governance arrangements and late and reactive in others.

2.3. Safety-I vs Safety-II

According to Hollnagel, Wears, and Braithwaite [19] the Safety-I perspective defines safety as the absence of accidents or incidents, meaning that a system is considered safe when as few things as possible go wrong. This traditional view focuses on preventing failures by identifying their causes and eliminating them. Safety management from this perspective is therefore reactive, as it responds to harmful events after they occur through investigations, corrective actions and stricter control measures. Human presence is often seen as a source of error and unpredictability that should be controlled through procedures, compliance and training. The goal of Safety-I is to ensure stable and predictable operations by minimising actions that differ from standard processes. While this approach has improved safety in many industries, it tends to emphasize what goes wrong rather than understanding the conditions that

enable things to go right [19].

A newer paradigm is Safety-II. Hollnagel, Wears, and Braithwaite [19] present the Safety-II perspective as a shift from viewing safety as the absence of failure to the ability of a system to succeed under changing conditions. It ensures that “as many things as possible go right. Instead of focusing only on accidents or malfunctions, Safety-II focuses on understanding how everyday operations normally succeed despite complexity, variability and pressure. Human presence is seen as a resource for flexibility and adaptation, as people continuously adapt to changing situations, preventing many potential failures before they occur. Consequently, Safety-II promotes a proactive and adaptive approach to safety management, where learning is based not only on what goes wrong but also on how and why things usually go right. This paradigm supports a more resilient system that can anticipate, respond and adapt to both expected and unexpected conditions and innovation [19].

2.3.1. Safety governance in energy and maritime

In the governance of complex energy systems, such as offshore wind developments, the contrast between Safety-I and Safety-II approaches is visible in how regulations, risk management and coordination are organised across sectors. Traditionally many high-risk sectors including energy and maritime transport have operated closer to a Safety-I mode of governance, where regulators establish detailed rules, standards and procedures and organisations are judged on compliance [9]. Safety governance structures tend to be hierarchical, for example, a government imposes regulations, and each operator or agency has a defined set of responsibilities to follow those rules. Coordination between institutions is often driven by incident response or legal requirements [4]. Risk assessments typically focus on worst-case events or past incident patterns.

For example, in offshore energy projects, this might mean setting fixed exclusion zones, technical design safety factors and emergency response plans based on past incidents. Risk assessment methods use an analytical approach focussing on finding the parts of a system that create risks, so those parts can be made more reliable and the overall risk becomes lower. Examples of this include FMEA, the Bowtie method and HAZOP. The emphasis is on compliance with regulations and reacting to issues. Investigations after an accident lead to new rules or penalties and safety is measured by the number of incidents [53]. While this approach can improve safety up to a point, it is often slow to adapt to new risks or technologies. In the offshore energy governance, especially when it is unsure how the OWFs will develop, a reactive approach might not adapt to the rapidly growing industry quickly enough.

A Safety-II approach leads to a more flexible and proactive way of governing safety, which fits better with complex and changing systems. Instead of only creating strict rules, authorities set overall safety goals and performance standards. For example, a small gas plant must ensure that its sulphur dioxide emissions stay below a set one-hour limit, but it is free to choose any technology to achieve this result [1]. Operators are allowed to decide how to meet these goals, as long as they can show that they are managing risks continuously. Governance also becomes more adaptive and collaborative. Different agencies and industry actors share responsibility for safety and work together more closely [19]. In offshore wind, this means that maritime safety is not handled by a single authority. Instead, energy regulators, maritime authorities and wind farm operators together make plans for safety and share information with each other.

Risk assessment also becomes more continuous and forward-looking. Rather than relying on a single study during project approval, there are ongoing checks such as monitoring operations, reporting near-misses and regular reviews on the whole system to adjust to new situations (e.g. new wind farms, changes in shipping routes) [45]. Safety-II governance may include regular meetings or working groups where government, industry and researchers discuss emerging risks and learn from everyday operations. Finally, in offshore wind and maritime governance, a Safety-II approach means involving safety experts early in planning processes, setting performance based safety goals and strengthening coordination across sectors (such as energy planners, coast guards, navies and fisheries). This helps manage risks that arise from the many interactions within the wider system.

In summary, applying Safety-II in maritime governance means combining prescriptive regulations with performance-based mechanisms that encourage innovation and learning. It shifts the culture from compliance only to one of commitment to keeping systems safe, even when the system changes. For

offshore wind, which sits at the intersection between energy policy and maritime activity, this shift of perspective could mean regulators and industry develop shared safety indicators, emergency response plans and execute iterative risk reviews. The outcome is a governance system that is more adaptive, preventive and system focused, better capable of balancing rapid energy expansion and maritime safety.

2.3.2. Safety-II in high-risk sectors

The shift from Safety-I to Safety-II has also taken place in other high-risk industries. In aviation, Safety Management Systems illustrate this shift: incidents are no longer the primary trigger for regulatory change and airlines are required to continuously monitor everyday operations, identify emerging risks and share information with authorities [13, 23, 43]. This approach emphasises systems-wide learning, two-way communication and the role of humans as proactive contributors to safety, which are core principles of Safety-II.

A similar development is seen in energy systems research [44, 45]. Future decentralised energy systems require methods that capture system-wide interactions beyond component failures (e.g., FRAM or AcciMap), aligning with Safety-II's focus on adaptation, local autonomy and performance-based safety management.

2.3.3. Process of proactive governance

Haapasaari et al. [15] describes a pathway for shifting towards proactive governance. First, a permanent stakeholder committee should share responsibility for risk governance, supported by an independent scientific body that performs ongoing risk assessments. These assessments must use up-to-date information, including incident and near-miss reports. They must rely on methods that can evaluate both current and future risks under uncertainty. Clear risk criteria also need to be agreed upon, covering impacts on people, society and the environment. Communication must be continuous across stakeholders, experts and international bodies, through both formal and informal channels. Finally, Safety-II must complement rather than replace international prescriptive rules, allowing proactive learning mechanisms to operate alongside regulatory compliance.

2.3.4. Offshore wind and maritime safety

In offshore wind governance, the dominant safety paradigm shapes when safety can still influence key planning choices. Under Safety-I, safety is primarily treated as compliance and mitigation. Safety concerns tend to be taken into account once risks are defined and plans are already stabilising, so safety enters later as measures within a largely fixed project scope. Under Safety-II, safety is treated as an adaptive capacity under uncertainty. Safety actors are involved earlier to shape spatial and design decisions, while remaining uncertainty is managed through monitoring, learning and iterative adjustment as the system scales. Chapter 3 operationalises this timing mechanism into the analytical dimension on Safety-I/Safety-II.

2.4. Dual-layer compliance in safety governance

What it is and why it makes sense

A dual-layer compliance system combines a prescriptive baseline that sets non-negotiable minimum requirements (e.g., rules, zones, technical standards, permit conditions) with performance-based oversight that requires actors to demonstrate acceptable risk through evidence, monitoring and assessments. This structure is common in complex offshore domains where a single prescriptive procedure is hard to standardise across different technologies and site conditions, making risk-based and adaptive approaches attractive [61]. Verling et al. [61] argue that highly variable offshore conditions make “one-size-fits-all” prescriptive procedures difficult, motivating risk-based and adaptive approaches supported by monitoring and learning. The Norwegian offshore regulation case similarly shows a shift from prescriptive permitting toward risk-based regulation as complexity and knowledge demands increased. However, they emphasise the importance of regulatory capacity to oversee industry evidence [24].

A purely prescriptive approach can be weak in rapidly evolving systems because risks and operating practices change faster than rules can be updated. Conversely, purely performance-based regulation can fail when oversight capacity is limited. If regulators cannot evaluate evidence credibly or enforce

follow-up actions, accountability becomes unclear and compliance can become symbolic. The rationale for a dual-layer system is therefore to preserve accountability through a minimum safety floor while enabling adaptation through evidence, monitoring and learning where uncertainty is unavoidable.

Compliance in offshore wind governance

In offshore wind planning and consenting, this implies that a minimum safety baseline can reduce ambiguity about non-negotiable requirements. An additional performance layer can address uncertainties that cannot be resolved at the permitting stage. Chapter 3 operationalises this dual-layer logic into empirical indicators (e.g., baseline requirements, oversight design, who evaluates evidence).

2.5. Synthesis and expectations for the analytical framework

This chapter shows that shipping safety integration in offshore wind cannot be explained by technical risk assessment alone. In periods of rapid scale-up, safety outcomes depend on how authority and coordination are organised, which safety logic dominates decision-making and how compliance and assurance are produced in practice.

Where safety responsibilities and requirements are clearly aligned across vertical governance levels (e.g., mutually consistent mandates, criteria and evidence expectations), shipping safety is expected to become binding earlier and more consistently across planning stages. Conversely, misalignment between levels, unclear delegation or slow approval processes is expected to delay the point at which safety considerations become binding.

Where cross-sector coordination mechanisms are strong and sectoral influence is balanced, safety trade-offs are expected to be integrated with fewer late-stage conflicts. Where coordination arenas are weak or influence is limited, safety is expected to appear later as a constraint rather than an early design principle.

Under a Safety-I orientation, safety is expected to enter late as compliance and mitigation once plans become concrete or risks become visible. Under a Safety-II orientation, safety is expected to enter earlier through iterative learning and adaptation under uncertainty.

Where a non-negotiable prescriptive baseline is complemented by credible performance-based oversight, compliance is expected to support both accountability and adaptation as conditions change. Where only minimum legal compliance dominates (or where performance-based oversight lacks credible evaluation capacity), assurance is expected to become procedural rather than adaptive.

The four perspectives reviewed above each explain part of the governance and safety challenge in offshore wind planning. However, the empirical question of this thesis requires an integrated lens. Chapter 3 therefore translates these theoretical insights into a single analytical framework for the empirical analysis. It produces analytical dimensions and specifies observable indicators and evidence sources to guide document analysis and stakeholder interviews. This provides a consistent framework for comparing how maritime safety is integrated into offshore wind planning in the Netherlands and the United Kingdom.

2.6. Conclusion

This chapter established the theoretical lens for analysing maritime safety integration in offshore wind governance. It identifies four complementary dimensions: Vertical coordination across governance levels, horizontal coordination and sectoral influence, the dominant safety paradigm (Safety-I vs Safety-II) and dual-layer compliance. Together these dimensions shape when and how safety becomes embedded in planning and consenting. The challenge of this thesis is to couple these layers, integrating the vertical hierarchy (MLG) with the horizontal network (Polycentricity) and the safety logic (Safety-II). Chapter 3 operationalises the four dimensions into indicators and evidence sources (Table 3.1) and summarises the integrated framework in Figure 3.1, which guide the empirical analysis.

3

A combined framework for safety management in offshore wind governance

The previous chapter showed that offshore wind development takes place in a governance setting where authority is distributed across multiple levels and across different sectors. These authorities share and compete for the same maritime space. At the same time literature shows that safety can be incorporated in planning either late and reactive or early and proactive. While each theoretical perspective offers valuable insights on its own, none of them fully explains how maritime safety becomes integrated or overlooked in offshore wind governance.

To understand safety policy outcomes in offshore wind, it is therefore necessary to examine the interaction between governance arrangements, safety paradigms and the mechanisms through which compliance and assurance are produced. Decisions about safety are shaped not only by technical risk assessments, but also by how responsibilities are distributed and how strongly different actors can influence planning.

This chapter translates the theoretical foundations from Chapter 2 into an analytical framework used in the empirical analysis. It first explains why four perspectives are needed (Section 3.1), then defines four analytical dimensions (Section 3.2), and finally summarises their operationalisation in indicators and evidence sources (Table 3.1) and in a conceptual model (Figure 3.1), which Chapter 4 uses to structure data collection and analysis.

3.1. Reason for combining the four perspectives

The perspectives introduced in chapter 2 each describe a different part of the governance challenge in offshore wind development. Multi-level governance focuses on the vertical distribution of authority across international, national and regional levels. Polycentric governance describes the horizontal interaction and competition between sectors sharing the same maritime space. The Safety-I/Safety-II perspective explains how safety concerns enter decision-making either late and reactive or early and proactively. Finally, the dual-layer compliance perspective emphasises that safety is shaped through a mix of formal legal requirements and softer instruments such as standards, guidance and assurance practices. Individually, each theory provides valuable explanatory insights, but none of them offers a complete understanding of how maritime safety becomes integrated in offshore wind planning.

Multi-level governance helps identify how rules and responsibilities travel across levels and how higher-level objectives constrain planning. However, vertical alignment does not by itself determine whether safety is prioritised in concrete planning choices. International frameworks may be incomplete or leave room for interpretation. National frameworks can still allow interpretation at the plan level. Even when mandates are clear and aligned across levels, safety considerations may still be outweighed by com-

peting sectoral interests or brought into planning only after other priorities are settled. This indicates that vertical coordination is necessary but not sufficient for understanding safety integration.

Polycentric governance adds that offshore wind planning takes place in a setting where multiple actors hold partial authority and must coordinate without a single actor being able to decide on outcomes. Because actors represent different sectoral interests, planning becomes a site of negotiation in which influence, conflict management and coordination arenas shape which priorities are integrated in decisions. Yet, actor influence alone does not determine whether safety is included early or late. Even where safety actors participate strongly, their impact depends on how safety itself is understood, if risks are visible and how they justify claims.

The Safety-I/Safety-II perspective therefore introduces a third component with the safety paradigm. It explains the timing and mode of safety integration. Under safety-I logic, safety measures are typically added once risks are visible or incidents have occurred. In a Safety-II logic, safety is integrated early through proactive monitoring, learning and anticipation. Whether safety is treated as a compliance check or as a continuous learning process influences whether safety supports decision-making from the start or delays decisions until risks are fully known.

Finally, dual-layer compliance explains how safety requirements become binding in practice. Formal regulation may set minimum obligations and accountability, while standards, guidance, certification practices shape what is treated as acceptable and how assurance is demonstrated. This matters for offshore wind because rapid technological and spatial expansion can outpace rulemaking, making the assurance a key pathway through which safety is operationalised.

Taken together, these perspectives are the basis for a combined analytical framework that links vertical authority, horizontal coordination, safety logic and compliance and assurance mechanisms. The next section translates these insights into analytical dimensions and indicators that guide the empirical analysis.

3.2. Analytical framework

The previous section showed why multi-level governance, polycentric governance and the Safety-I/Safety-II perspectives complement one another when analysing how maritime safety becomes integrated into offshore wind planning. To make these theoretical insights usable for empirical research, this section translates them into dimensions. These dimensions show the mechanisms through which governance structures influence the timing, form of safety integration and balancing of interests. It combines the four theoretical perspectives into one framework for analysing the integration of maritime safety in offshore wind planning. Together, they make it possible to compare how different institutional contexts incorporate maritime safety into offshore wind development.

Definition of alignment

In this thesis, alignment refers to the degree to which responsibilities, decision criteria and evidence expectations are made mutually compatible across the offshore wind planning chain (across governance levels and across decision arenas [63]). Alignment is therefore more than interaction or consultation. It exists when safety expectations and their justification become sufficiently shared, stable and enforceable to make decisions consistently and reduce late-stage dispute. The framework, distinguishes between vertical alignment (consistency across governance levels) and horizontal alignment (compatibility across sectors and arenas). Throughout the thesis the terms “upstream” and “downstream” are used to indicate position in the planning and consenting chain. Upstream means earlier, plan-led steering stages, while downstream means later, project-level consenting and implementation stages.

3.2.1. Vertical coordination across governance levels

The first analytical dimension concerns how safety is coordinated between international, national and regional governance levels. This dimension focuses on whether mandates and rules are aligned across levels of authority and whether procedures facilitate or hinder the integration of safety into planning. Vertical coordination includes the implementation of international regulations and guidelines, the translation of regional recommendations into national policy and the interaction between national ministries and regional or local authorities.

When vertical coordination is strong, roles are clear, requirements are predictable and there is upward and downward information exchange. International guidelines or standards are translated consistently into national spatial plans, which reduces uncertainty and allows safety actors to participate early in planning. When vertical coordination is weak, unclear mandates, conflicting requirements or slow multi-level approval processes may delay or complicate safety integration.

A further element of vertical coordination concerns how safety responsibilities are delegated downward. In some countries, higher-level institutions prescribe detailed and binding safety measures that developers must implement, leaving little discretion at lower levels. In others, higher levels define only general safety goals and allow developers or operators to determine how to achieve them in practice. This difference reflects how authority over safety decisions is distributed vertically. Either prescriptive requirements centralise control or performance-based requirements decentralise responsibility to lower government levels or private actors. Whether international requirements are binding or allow room for interpretation also shapes national decision-making. Strictly binding regulations limit tailor-made regulations for regions but support harmonisation across jurisdictions, whereas non-binding guidelines give national governments flexibility but may result in inconsistent safety approaches across countries.

Guiding questions for analysis:

- How are requirements from international and regional levels translated into national spatial planning and permitting criteria?
- Where do responsibilities shift between levels (who decides, who assures, who implements), and does delegation centralise control or decentralise responsibility?
- Are there vertical bottlenecks that delay the point at which safety becomes binding?

3.2.2. Horizontal coordination and balance of influence between sectors

The second analytical dimension addresses how actors and sectors interact within the planning process and how their interests shape decisions. Offshore wind development involves multiple sectors with different priorities, including energy production, maritime transport, fisheries, environmental protection, defence and maritime safety authorities. Coordination mechanisms exist in most planning processes, but the degree to which actors can influence outcomes varies.

When horizontal coordination is strong and balanced, trade-offs are openly negotiated and safety concerns are considered alongside economic and environmental objectives. In such settings, actors are involved early in planning, disagreements are resolved through formal mechanisms and decision-making reflects shared responsibility rather than the dominance of one sector. When coordination is weak or unbalanced, the consultation does not guarantee influence. One or a few sectors can dominate decision-making and competition for maritime space may lead to conflicts rather than collaborative negotiation. Safety concerns may be raised late or addressed only after important decisions, like spatial decisions, have already been made.

An important aspect of horizontal coordination is not only which actors are present, but also how coordination is organised. Planning procedures and governance mechanisms, such as marine spatial planning processes, environmental and safety permit procedures and sectoral working groups, determine when and how actors participate, how trade-offs are evaluated and how conflicts are resolved. These mechanisms may balance influence evenly across sectors or they may systematically prioritise certain interests over others (for example, energy production over maritime safety). Thus, actor involvement must be analysed both in terms of participation and in terms of decision-making power, and whether planning mechanisms ensure that actors' interests are weighted equally or whether institutional design allows certain sectors to dominate outcomes.

In practice, horizontal coordination is not only shaped by formal consultation and mandatory procedures, but also by informal arenas such as recurring working groups, bilateral alignments and expert networks. This is where ideas are tested and pre-agreements are formed before decisions are formalised. Participation in these arenas can create asymmetries, because actors who are consistently present can build trust, shape problem definitions and influence which options are considered feasible. Influence also operates through agenda-setting and timing, where safety issues can be raised early or deferred to later stages where they are treated as project-level mitigation rather than as constraints on

site choice.

Guiding questions for analysis:

- Which coordination arenas structure cross-sector interaction (formal and informal) and when do maritime safety actors enter these arenas?
- How are trade-offs between sectors negotiated and what structural or relational power shapes whose priorities dominate?
- How are conflicts resolved, and do safety concerns shape early spatial choices or appear late as project-level mitigation?

3.2.3. Timing and mode of safety integration (Safety-I vs. Safety-II)

The third analytical dimension addresses how safety is approached within the planning process, particularly whether it is integrated proactively or reactive. In a Safety-I perspective, safety management focuses on preventing failures through compliance with prescribed requirements. Safety tends to enter planning late, after spatial and economic decisions have been made and after specific risks become visible. This approach is commonly associated with prescriptive rules, fixed safety distances and strict compliance requirements. While it can prevent known hazards, it may also result in lengthy assessment cycles if decisions are postponed until risks are fully quantified.

In a Safety-II logic, safety is defined as the ability of the system to function successfully under varying conditions and uncertainty. Safety is integrated early in planning and risk assessments consider cumulative and future developments rather than only site-specific effects. Safety actors engage regularly throughout the process. Instead of eliminating uncertainty before decisions are made, uncertainty is managed dynamically through monitoring and adaptation during development. This approach can increase information demands and create pressure for iterative assessments.

A key distinction between the two perspectives concerns how the trade-off between operational feasibility and thorough risk assessment is handled. A Safety-I approach may slow the planning process, as decisions await complete certainty about risk. A Safety-II approach accepts that complete certainty is impossible and manages risk adaptively to allow development to progress while safety is safeguarded. Consequently, the safety perspective influences whether safety is perceived as a barrier to time-sensitive offshore wind development or as an enabling component integrated throughout planning and operations. A key aspect is the presence of decision lock-in points and windows of influence. Early stages can still change spatial choices, whereas later stages typically restrict safety to mitigation within a largely fixed project scope.

Guiding questions for analysis:

- When does safety enter decision-making relative to lock-in points: early enough to shape spatial/design choices or mainly after plans become concrete?
- Is risk assessed as project-specific compliance (Safety-I) or as cumulative/system-wide anticipation under uncertainty (Safety-II)?
- Are uncertainty and change handled through iterative monitoring/learning and updates or by waiting for certainty before decisions are made?

3.2.4. Dual-layer compliance structure

The previous dimensions address when and through which coordination mechanisms safety is integrated in offshore wind planning. An additional question concerns how compliance with safety expectations is verified. In complex and developing technical systems such as offshore wind, only prescriptive regulation is often insufficient because risks evolve faster than rule-making. Purely performance-based regulation can lack enforceability and clear accountability. To address this challenge, safety governance can develop as a dual-layer compliance structure. The first layer establishes a prescriptive safety baseline, where regulators verify compliance with non-negotiable minimum requirements such as documentation, equipment certification, navigational safety distances and emergency preparedness. This ensures that all developers operate from a guaranteed safety floor (Safety-I logic). The second layer builds on top of this baseline through performance-based oversight, in which regulators eval-

uate whether actors are achieving intended safety outcomes in practice. This is done through evidence such as risk monitoring, incident and near-miss reporting, learning cycles and adaptive planning (Safety-II logic). Together, the two layers shape an integrated enforcement mechanism that preserves accountability through minimum standards while enabling proactive safety management under uncertainty. This dimension therefore builds on the earlier analytical dimensions by emphasising that effective safety integration requires not only early involvement and coordination mechanisms, but also a credible system for verifying both rule compliance and actual safety performance.

Whereas the safety mode captures when and how safety enters planning and consenting (i.e., the dominant safety logic and approach to uncertainty), this dimension captures how safety requirements are operationalised and enforced during the project through assurance mechanisms such as monitoring, reporting, inspection and enforcement.

Guiding questions for analysis:

- What non-negotiable prescriptive baseline exists (rules, zones, permit/consent conditions), and how clearly does it define minimum expectations?
- Does oversight cover the project lifecycle and feed back into updated requirements or adapted conditions as practice and risks evolve?

Table 3.1 summarises the indicators and evidence sources used to analyse this dimension.

The first three dimensions describe how and when safety is integrated into offshore wind planning, whereas the fourth dimension concerns how compliance is ensured in practice. It combines prescriptive minimum standards with performance-based oversight to verify whether both regulatory and real-world safety outcomes are achieved.

3.3. Operationalisation of the framework

The analytical framework is operationalised in Table 3.1 through indicators that translate the theoretical dimensions into observable features in policy documents, planning procedures and stakeholder interviews. These indicators guide data collection and analysis in the empirical chapters and ensure that both cases (the Netherlands and the United Kingdom) are examined systematically and comparably.

Analytical dimension	Integrated indicators for empirical analysis	Typical sources of evidence
1. Vertical coordination across governance levels	<ul style="list-style-type: none"> – Consistency of safety requirements across IMO/EU/national levels – Binding vs non-binding nature of international guidance – Prescriptiveness vs flexibility in international safety requirements – How requirements are translated into planning and permitting criteria – Responsibilities (who decides, who assures, who implements) – Approval timelines and bottlenecks across levels/stages 	<ul style="list-style-type: none"> – National marine spatial plans / national programmes – Safety regulations and technical standards (IMO/EU + national implementation) – Guidance and implementation documentation – Interviews with ministries and regulators
2. Horizontal coordination and balance of interests between sectors	<ul style="list-style-type: none"> – Which actors are involved, at what stage and with what influence – Mechanisms for cross-sector coordination (spatial planning, consultation, working groups) – Structural power (mandates, legal constraints, roles) shaping outcomes – Informal coordination arenas and knowledge power – How trade-offs are negotiated between sectors and how agreements are reached – Records of objections/support and how conflicts are resolved – Experiences of conflict, dominance or marginalisation between sectors 	<ul style="list-style-type: none"> – Stakeholder consultation documentation – Steering committee outputs – Sector position papers – Planning process descriptions – Interviews with maritime safety, transport, energy departments
3. Timing and mode of safety integration (Safety-I vs Safety-II)	<ul style="list-style-type: none"> – When safety enters: search-area stage vs project permitting/consent – Scope of risk assessment: project-based vs cumulative/system-wide – Frequency and nature of revisions/updates to safety requirements – Lock-in moments – Risk acceptance criteria / residual risk logic (e.g., <i>restrisico</i>, ALARP-type reasoning) – How uncertainty is handled: waiting for certainty vs managing uncertainty adaptively – Use of standard methods/frameworks as boundary objects (e.g., <i>afwegingskader</i> / FSA-methodiek) – Degree of continuous monitoring and learning (feedback from operations into planning/consenting) 	<ul style="list-style-type: none"> – Risk assessment procedures and reports (e.g., NRA / EIA / SEA) – Emergency response / safety planning documentation – Incident/near-miss reporting processes (where available) – Interviews with maritime authorities and safety experts
4. Dual-layer compliance structure (prescriptive baseline + performance-based oversight)	<ul style="list-style-type: none"> – Non-negotiable minimum safety rules (Safety zones, mandatory procedures) – Performance-based mechanisms (Monitoring, periodic reviews, reporting duties) – How regulators evaluate safety performance vs formal/administrative compliance – Whether oversight focuses on operational behaviour and lifecycle compliance – Existence of learning cycles and adaptive requirements (how conditions/guidance evolve over time) – Funding responsibility for safety measures (who pays / who implements) 	<ul style="list-style-type: none"> – Permit/consent conditions – Inspection/enforcement approaches and audit regimes – Monitoring and reporting outputs – Interviews with inspectors and operators/developers

Table 3.1: Operationalisation of the analytical framework for empirical analysis

The following methodology chapter explains how these indicators are applied in document analysis and stakeholder interviews to compare the integration of maritime safety in offshore wind planning in the Netherlands and the United Kingdom.

3.4. Conceptual model

Figure 3.1 presents the combined conceptual model that follows from the analytical framework developed in this chapter. The model summarises how governance structures and safety perspectives jointly shape the integration of maritime safety in offshore wind planning.

At the top of the model, vertical and horizontal coordination represent the main governance conditions that influence whether and how safety is considered in planning decisions. Vertical coordination captures how responsibilities and safety requirements are distributed across international, national and regional regulatory levels and the extent to which these requirements are aligned and predictable. Horizontal coordination captures how different sectoral institutions (energy developers, maritime safety authorities, shipping representatives, environmental agencies and the defence sector) interact, cooperate and negotiate during planning processes. It shows how coordination mechanisms and power imbalances structure their influence.

Beneath these governance conditions, the model includes two parallel safety mechanisms that deter-

mine how safety concerns are operationalised in planning. The first mechanism is the safety paradigm in planning, which reflects whether safety is approached as a reactive compliance-driven matter (Safety-I) or as a proactive and adaptive learning process (Safety-II). The second mechanism is the dual-layer compliance structure, which specifies how regulators verify whether safety expectations are being achieved in practice. This dimension consists of a non-negotiable prescriptive baseline ensuring minimum safety requirements and a performance-based oversight layer in which compliance is assessed through evidence of actual safety performance and learning. A key implication is the presence of feedback loops. Monitoring and oversight during construction and operation can trigger revisions of guidance, permit conditions or baseline requirements in later planning rounds. Where the safety paradigm captures when and how safety enters planning and how uncertainty is treated, the dual-layer structure captures how requirements become enforceable and how compliance is verified over the project lifecycle.

Taken together, the conceptual model proposes that safety integration in offshore wind planning is not determined solely by project-level risk assessments, but by the interaction between governance arrangements and the safety mechanisms applied in planning and regulation. The distribution of authority across governance levels, the balance of influence between sectors and the underlying safety paradigm shape the observable safety outcomes present in each case. Examples include safety distances around wind farms, multi-use access rules and the provision of emergency towing vessels.

In this way, the conceptual model links governance mechanisms and safety mechanisms to safety outcomes. This model guides the empirical analysis of the Netherlands and the United Kingdom in the subsequent chapters.

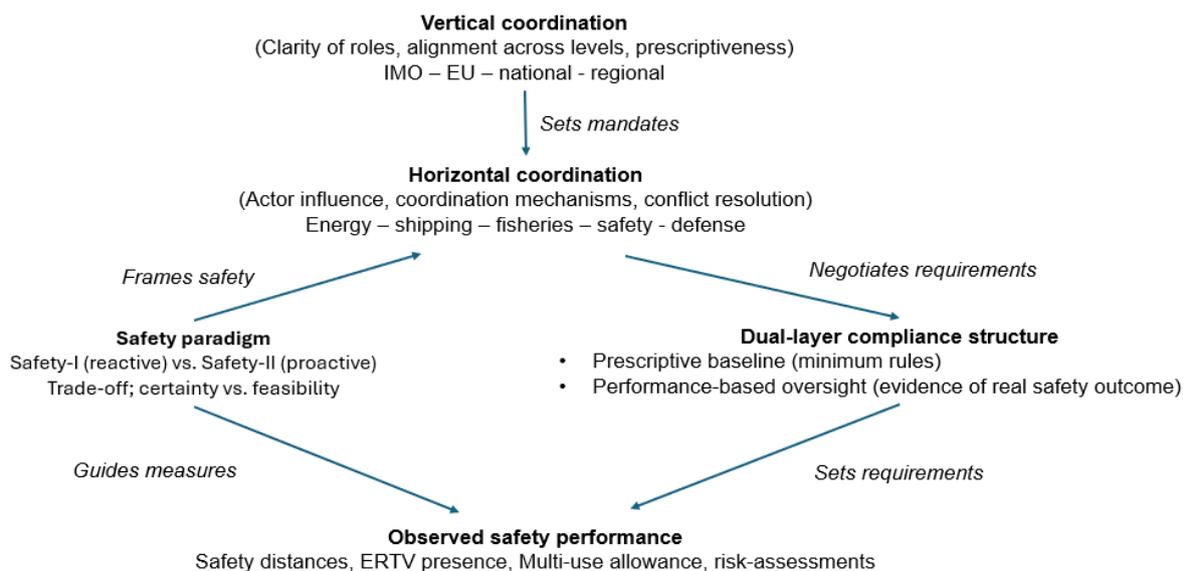


Figure 3.1: Conceptual model linking governance mechanisms and safety paradigms

To complement the cross-case analysis, each case chapter ends with one to two mini-cases to illustrate key mechanisms. The selection is explained in Chapter 4.

4

Research Methodology

Building on the analytical framework developed in Chapter 3, this chapter explains how the cases were selected, what data were collected and how the analysis was conducted. The chapter first explains the comparative qualitative case study design and the selection of the Netherlands and the United Kingdom as cases. It then describes the data sources used (documents, interviews, and observations) and access. Finally, it explains the analytical procedure used to develop within-case narratives and a cross-case comparison structured by the four analytical dimensions. Definitions of the four dimensions are provided in Chapter 3 and operationalised in Table 3.1. This chapter focuses on how they are applied in the research design and analysis.

4.1. Research design

This research adopts a comparative qualitative case study design to examine how variations in coordination mechanisms and policy-dynamics shape the integration of maritime safety into offshore wind governance. A qualitative design is necessary because the processes of coordination, negotiation and safety integration involve relationships, sectoral interests and perceptions that might not be captured through quantitative analysis alone. Instead, the qualitative approach enables an analysis of how actors collaborate, compete and prioritise safety within planning practice.

Case comparison

The study compares two countries: The Netherlands and The United Kingdom. Both are in a scale-up phase of offshore wind development, operate in the same maritime area and face similar spatial and operational conditions (lots of shipping activity, fishing activity, relatively shallow waters and rapid expansion of offshore wind capacity). However, they might differ in their institutional arrangements and policy traditions, which makes them suitable for a comparison. Another important factor is the different role of the European Union. Where The Netherlands is part of the EU regulatory frameworks, The United Kingdom now operates outside of them. This might result in substantial differences in the vertical component of the framework. Comparing the two therefore allows the study to explore whether the presence or absence of EU regulations influences the integration of maritime safety into offshore wind governance.

The comparison also aligns with the research strategy of answering the sub-questions presented in Chapter 1. By examining each country through the same dimensions, vertical coordination across governance levels, horizontal coordination and the timing and mode of safety integration, the research makes it possible to identify the mechanisms shaping safety integration and how differences in these mechanisms help explain differences in safety measures. The next section identifies the specific country cases selected for comparison and explains how their characteristics support the analytical goals of the research design.

Temporal and phase scope

Because the framework focuses on when safety enters the planning process, each country case is analysed by planning phase, from strategic marine spatial planning, site designation or leasing to consenting & permitting. The four analytical dimensions are applied to trace how maritime safety is integrated and where influence and lock-in points occur. In addition, the study looks back at how the governance process is formed by scaling up the technology and industry defining moments and accidents. This allows the analysis to capture how safety integration evolves as offshore wind scales up and why late intervention becomes more difficult once decisions are funnelled into formal procedures.

4.2. Case selection and justification

The study focuses on two country cases: the Netherlands and the United Kingdom. The selection is based on the following criteria:

- **Similar stage of offshore wind development**

Both countries are in a large-scale phase of their offshore wind deployment.

- **Netherlands:** Rapid acceleration since 2016, with large-scale offshore wind zones and an integrated long-term roadmap targeting 21 GW by 2032 and 70+ GW by 2050 [27].
- **United Kingdom:** Largest offshore wind capacity in Europe, with mature commercial projects since 2008 and a legally binding target of 50 GW by 2030. Both are currently transitioning from individual-project deployment to system-level expansion [10].

- **Similar physical and operational conditions**

The Dutch and United Kingdom sectors of the North Sea share highly comparable maritime conditions relevant for safety:

- Dense commercial shipping lanes connecting North Sea ports to global trade routes.
- Both countries have an established fishing sector with high activity in the North Sea [65].
- Shallow continental seas enabling bottom-fixed turbines and large construction areas. Even though the United Kingdom also has a deeper sea area in the north, the southern part of the North Sea is characterized by shallow seas. These similarities create a controlled setting in which governance mechanisms, not geography, can explain policy differences.

- **Similar safety relevance** Both countries have long maritime histories and well-developed safety institutions:

- **Netherlands:** Rijkswaterstaat, Coast Guard, The Human Environment and Transport Inspectorate (ILT) and the Royal Netherlands Navy are central maritime actors with a high priority on navigational safety in the North Sea. In addition, the state commissions environmental and navigational risk assessments, including the use of tools such as SAMSON to quantify collision and grounding risks around planned wind farms [33].
- **United Kingdom:** The Maritime and Coastguard Agency (MCA), Trinity House and the Royal National Lifeboat Institution (RNLI) play similar roles, supported by strong offshore energy safety regulation since the Piper Alpha disaster [17].
- Because maritime activity is politically and economically significant in both states, contrasts in safety integration cannot be attributed to lack of institutional capability.

These shared contextual features ensure that differences in maritime safety integration cannot be attributed solely to geographical, economic or technological factors.

Despite these shared characteristics, the Netherlands and the United Kingdom differ in ways that are theoretically informative for the analysis:

- **Distinct institutional and coordination mechanisms**

The Netherlands is characterised by a more centralised and integrated spatial planning system, whereas the United Kingdom follows a more decentralised governance model with separate planning for every planned wind farm [22].

- **The role of European Union governance**

The Netherlands must implement EU maritime and offshore renewable directives, whereas the United Kingdom now operates outside EU regulatory structures after Brexit. This difference creates an opportunity to investigate whether and how EU involvement influences the integration of maritime safety into offshore wind governance.

- **Variation in approaches to multi-use and coexistence**

The Netherlands allows vessels up to 24 meter inside OWFs under the condition that their AIS is functioning. Fishing is only allowed in designated areas. The United Kingdom allows all vessels to enter OWFs. Safety is the responsibility of the captain of the vessel. Other activities are also allowed inside the OWF.

These contrasting institutional conditions make the Netherlands and the United Kingdom well-suited for an explanatory comparison. Analysing each case through the same four analytical dimensions, vertical coordination across governance levels, horizontal coordination and actor influence, and the timing and mode of safety integration, enables identification of how different coordination mechanisms and policy-making dynamics contribute to differences in observed safety outcomes.

This “most-similar systems’ setup reduces geographic/technical explanations, so observed differences are more likely linked to governance coordination and safety-assurance mechanisms.

4.3. Data collection

This section describes the data that is needed to answer the research questions, how this data is collected and how it is systematically analysed. Information is collected through a thematic document review and semi-structured interviews.

4.3.1. Document review

To collect existing knowledge on the processes and policy measures in offshore wind governance, a literature and document study is conducted. The literature was retrieved through Scopus, Google Scholar and the TU Delft repository, focusing on research covering offshore wind planning, multi-level and polycentric governance, maritime safety management and risk governance in high-risk socio-technical systems. Alongside academic literature, sources of grey literature are analysed, including policy documents, marine spatial plans, consultation records and documents/guidelines from the IMO, IALA and national maritime authorities. These documents are used because they represent the formal mechanisms through which safety considerations enter policy and planning processes and therefore support comparison between the two country cases.

The findings from the literature and document provide a contextual understanding of how offshore wind governance and maritime safety regulations have developed in the Netherlands and the United Kingdom. Second, they act as comparative material for the empirical interview data, enabling identification of similarity or differences between formal procedures and stakeholder experiences in practice.

4.3.2. Semi-structured interviews

Semi-structured interviews were conducted to collect empirical data for this research. The semi-structured format ensures sufficient flexibility for both the researcher and the interviewees to explore topics in depth, while also maintaining comparability across interviews through a set of prepared questions. The interviews focused on stakeholders directly involved in offshore wind governance and maritime safety in the Netherlands and the United Kingdom.

Participants

Participants were selected based on their involvement in offshore wind spatial planning, maritime safety regulation or operational safety management. To capture a wide range of perspectives, interviews are held with representatives from different departments and governance levels. In the Netherlands, interviews were conducted with officials from the Ministry of Climate Policy and Green Growth, the Ministry of Infrastructure and Water Management (both from Safety and Environment departments), as well as with a representative involved in the Dutch North Sea Programme. In the United Kingdom, interviews are held with representatives from the Maritime and Coastguard Agency (MCA) and the Maritime

Management Organisation. Together, these participants cover a big part of the actors responsible for integrating maritime safety into offshore wind planning, regulation and implementation.

Expert name	Country	Organisation
Anonymous	The Netherlands	Ministry of Climate and Green Growth (Permitting)
Anonymous	The Netherlands	Ministry of Infrastructure & Water Management (Safety policy)
Anonymous	The Netherlands	Ministry of Infrastructure & Water Management (Marine Spatial Planning)
Anonymous	The Netherlands	Rijkswaterstaat (Spatial Planning)
2x anonymous	The United Kingdom	Maritime Coastguard Agency (Renewables & Navigational Safety)
Anonymous	The United Kingdom	Maritime Management Organisation

Table 4.1: Overview of the interviewed representatives involved in offshore wind planning.

The biggest challenge in the interviews was balancing an open conversation and allowing interviewees to raise issues that they thought were important, but in the meantime ensuring that the key themes of the thesis were addressed. To support this, each interview was guided by a topic list derived from the analytical framework.

Interview guide design and role-specific tailoring

The interviews were conducted after the initial document review and the development of the conceptual framework, so that interpretations could be tested and refined. During the interviews, the framework served as a topic map to verify how maritime safety is integrated into offshore wind planning in practice and to identify where formal procedures and informal coordination arenas play an important role.

In practice, interviews followed a two-step structure. They typically started with open questions that encouraged interviewees to describe the planning process and decision moments from their perspective. In the second part, the list was used to systematically discuss the process across the four dimensions. The focus and sequence of questions were adapted to the interviewee's expertise and institutional role. For interviewees working on offshore wind development and consenting, questions focused primarily on process dynamics and trade-offs between users. These interviews were then complemented with targeted questions on safety logic and assurance (Appendix C). For interviewees with marine spatial planning and/or maritime safety expertise, the same planning process topics were discussed to compare experiences, but more focus was placed on safety paradigms, risk assessment practice, and the mechanisms through which safety requirements become binding in practice (Appendix D). Despite this role-specific tailoring, all interviews addressed all four dimensions.

In total, four semi-structured interviews were conducted with policy advisors in the Netherlands, and two interviews were conducted in the United Kingdom with three policy advisors. All interviews were conducted online and lasted approximately 60-75 minutes.

4.3.3. Observations during meetings

In addition to document analysis and interviews, the research was shaped by observations in relevant policy and expert settings. These settings provided understanding of how shipping safety is discussed in practice, how coordination occurs across organisations and where key trade-offs show up. The observations were mainly used to understand document and interview findings, identify relevant actors and processes and support the selection and reconstruction of the mini-cases. Notes from the meetings and events were used as contextual material, instead of primary source of quotable evidence.

Fieldnotes were made immediately after meetings/events and summarised. No direct quotations from these settings are used unless explicitly agreed and independently supported through documentary or interview evidence.

Setting	Role / activity	Analytical contribution (link to framework)
North Sea Shipping Group meeting	Presented thesis topic and observed informal discussions	Insight into transboundary coordination challenges and the role of informal arenas in decisions
Expert meetings with shipping safety experts (RWS and I&W)	Participated in expert exchange on safety issues	Clarified how safety concerns are framed and how safety risks and evidence is identified (safety-mode & knowledge/data collection)
IALA Conference (one week)	Attended a committee meeting and informal exchanges with international experts	Broader view on standards and guidance development and emerging practices relevant to navigation safety (vertical coordination; standards)
Weekly meetings at I&W (maritime affairs team)	Regular participation as observer in internal team meetings	Understanding of internal coordination routines, agenda-setting and how policy positions are prepared (informal coordination arenas and agenda-setting)
Calls with experts (United Kingdom, Germany, Denmark, Sweden, Norway, France, Belgium)	Informal background conversations (not used as quotable evidence)	Context on how other countries approach similar issues; helped interpret the NL/United Kingdom cases and refine questions

Table 4.2: Observed meetings and practitioner engagement used for contextual understanding and triangulation.

4.4. Data analysis

The empirical analysis followed a structured workflow with framework-based coding, done with Atlas.ti. The goal was to trace how shipping safety is integrated into offshore wind planning and consenting in the Netherlands and the United Kingdom across governance coordination mechanisms and safety mechanisms.

4.4.1. Data preparation and organisation

All interviews were recorded and transcribed verbatim. The interviews with Dutch participants were held in Dutch, so had to be translated to English before they could be used. Transcripts were imported into Atlas.ti and organised by country and by the interviewees' role. Documents and papers supporting the empirical data were categorised by country and stage of the planning process.

4.4.2. Coding approach and codebook development

Codes were applied when an interesting text (typically a few sentences) that expressed a mechanism, justification or coordination dynamic occurred in an interview. Multiple codes could be applied to the same excerpt. Coding was conducted in Atlas.ti using a combination of deductive and inductive logic:

- An initial codebook was derived from the dimensions of the framework and Table 3.1 to ensure coverage of the four dimensions:
 1. Vertical coordination (VC)
 2. Horizontal coordination and sectoral influence (HC)
 3. Maritime safety: Safety Mode (MS)
 4. Maritime Safety: Dual layer compliance (DL)
- Inductive coding: During the coding, more codes were added to capture mechanisms that repeatedly came up in the data but were not fully covered by the initial framework wording or were very relevant for the case. These were grouped into themes such as Process Mechanics (PM) and Constraints & Trade-offs (CT).

4.4.3. Coding procedure and refinement

After the first cycle, the coding was refined through a second cycle of coding:

1. Second-cycle: Within each dimension, coding was refined to capture more specific mechanisms. For example: “informal coordination arenas” and “trade-off negotiation” within the horizontal coordination or “risk assessment scope” or “uncertainty handling” within the safety mode group.

First cycle codes were coded into more specific themes through comparison of the first cycle codes and searching patterns or themes that re-occurred. Codes were merged when they captured the same mechanism or specific theme. The final theme set was frozen when no more new themes occurred.

In total, the interviews contained 53 codes, organised into code groups based on the framework. These groups are later used to structure the results chapter.

Table 4.3 summarises the core themes derived from the Atlas.ti codebook, links them to the analytical framework, and reports indicative frequency by country. A full codebook and the coding tree are provided in Appendix E.

4.4.4. Within-case: from coded quotes to case narratives

For each country, code segments were combined into a structured case story organised by the main code groups. These observed mechanisms and dynamics were sequenced in the planning phases and time periods, resulting in a country-specific storyline, which explains:

- How responsibilities and requirements are distributed and aligned;
- How cross-sector coordination and influence shape trade-offs;
- When safety enters the process and how uncertainty/risk is treated;
- How requirements become enforceable and how compliance is structured;

The case results part also helped find one to two mini-cases per country. The mini-cases were selected to illustrate mechanisms that were important for the governance (e.g., lock-in moments, informal coordination shaping formal outcomes or translation of safety concerns into concrete permit conditions and oversight practices). They also demonstrate how the mechanisms were formed or changed, based on previous experiences. Cross-case comparison was conducted by contrasting the two cases along the same four dimensions, examining how differences in coordination and safety mechanisms help explain differences in observed outcomes. These cases were selected because they show a lock-in/turning point, a clear informal-to-formal translation, and traceable evidence across at least two sources (document + interview).

4.5. Ethical considerations

Ethical considerations in qualitative, semi-structured interviews require balancing the collection of valuable insights with the protection of participants' privacy, safety and professional interests. The informed consent signed by participants ensures participants understand the study's aim, what participation means, how data will be used and that they may withdraw at any point without consequences. Confidentiality is especially important in policy and regulatory settings, where comments could be politically sensitive and potentially confidential. The research therefore requires careful handling of personal data, secure storage and clear boundaries around what will and will not be reported.

To address these issues, all interviewees were provided with an informed consent form in advance and asked to sign prior to the interview. The consent form explained the purpose of the research, the voluntary nature of participation, the intended use of interview data (academic research and thesis reporting) and the right to withdraw. With permission, interviews were audio-recorded to ensure accuracy. To protect confidentiality, recordings and transcripts were anonymised. This means identifying information (names, specific job titles, organisation information where needed and project-specific details that could enable attribution) was removed during transcription. In the thesis, quotes are attributed only at an appropriate level of aggregation (e.g., “regulator”, “industry consultant”, “port authority”) to minimise re-identification risk. The consent form and data-handling protocol are provided in the appendix.

Table 4.3: Main themes found during coding

Core theme	Framework link	What it captures	Main codes (examples)	Indicative freq. (NL/UK/T)
Staging & lock-in	PM	Where safety enters the process, key phases, lock-in points, and delay/bottleneck dynamics.	PM_Process phase/stage; PM_Stage-gates/point-of-no-return; PM_Bottlenecks & delays	88/24/112
Criteria & traceability	PM	How decisions are justified and documented (auditability, written record, “why this choice”).	PM_Decision criteria used; PM_Traceability & documentation	58/21/79
Tools & evidence	PM / MS	Methods used to produce “defensible” safety arguments (risk assessments, evidence types, examples/case references).	PM_Tools & methods used; MS_Evidence basis; MS_Risk assessment scope; MS_Evidence politics; META_Example/case reference	122/43/165
Coordination arenas	HC	Formal and informal fora where coordination happens, including shared language and boundary objects.	HC_Formal coordination arenas; HC_Informal coordination arenas; HC_Shared language/boundary objects	53/30/83
Roles & mandates	VC	Role clarity, delegation, accountability, and vertical feedback between governance levels.	VC_Role clarity & accountability; VC_Mandate & delegation; VC_Upward/downward feedback	32/37/69
Influence & negotiation	HC	How actors shape outcomes through influence, contestation, negotiation, and power asymmetries.	HC_Actor influence (structural); HC_Actor influence (relational); HC_Conflict & contestation; HC_Trade-off negotiation; HC_Marginalisation/dominance	76/24/100
Constraints & trade-offs	CT	Feasibility constraints and “who pays” trade-offs; political/legal/technical limits and competing public values.	CT_Political feasibility; CT_Budget/who pays; CT_Competing public values; CT_Legal hard constraints; CT_Technical feasibility; CT_Capacity vs safety; CT_Conditionality	126/56/182
Compliance oversight	DL	Prescriptive baseline requirements plus performance/inspection/oversight mechanisms.	DL_Prescriptive requirements; DL_Performance oversight	34/24/58
Regulatory alignment	VC	Cross-border coordination and the stability/interpretation of rules across time, cases, and jurisdictions.	VC_International translation; VC_Cross-border coordination; VC_Regulatory stability vs change; VC_Interpretation space/ambiguity; VC_Consistency across cases	61/45/106
Risk & learning	MS / DL	How uncertainty/residual risk is treated and how learning/adaptation shows up (Safety-I/II, adaptive requirements).	MS_Uncertainty handling; MS_Risk acceptance/residual risk; MS_Safety-I framing; MS_Safety-II framing; MS_Safety concept ambiguity; DL_Learning cycles; DL_Adaptive requirements	82/42/124

5

Empirical case: The Netherlands

This chapter will examine how the Netherlands integrates maritime safety into offshore wind planning. It starts with an overview the planning process and preventive and reactive safety measures implemented around Dutch offshore wind farms. It then applies the analytical framework, vertical coordination, horizontal coordination, safety paradigm and compliance structure, to evaluate governance mechanisms. Relevant Dutch policy documents and planning instruments are identified throughout (e.g. the North Sea Programme 2022–2027, Noordzeeakkoord and Noordzeeoverleg, MOSWOZ reports, and Dutch Safety Board findings) with links for further reference. Interviews with experts are conducted to analyse more informal cooperation and mechanisms.

The Dutch case is structured around three explanatory patterns that will return in the cross-case synthesis. Plan-led spatial steering that stabilises safety early, strong institutional gatekeeping that still depends on proportionate, evidence-based justification and emerging Safety-II elements (e.g., scenario work, monitoring, near-miss learning) that are becoming more visible under scale-up pressure and incident attention, while Safety-I remains the baseline. Sections 5.1–5.2 describe the process and resulting instruments, Section 5.3 explains these outcomes through the four analytical dimensions, sections 5.4–5.5 illustrate two turning points that shaped the current model.

5.1. Process overview and timeline

This section maps the Dutch planning process and identifies where decisions become locked in for safety.

5.1.1. End-to-end process/stage

Dutch offshore wind planning and permitting follows a staged process that moves from strategic spatial planning to project-level site decisions, and then to tendering, construction and operations. From a shipping-safety perspective, maritime safety enters this process early and remains embedded as a recurring assessment and decision criteria rather than being introduced only at the end of permitting. Across interviews, maritime safety is consistently framed as a boundary condition (*randvoorwaarde*) for offshore wind planning. Projects should not proceed unless safety can be defensibly maintained. This headline framing shapes how trade-offs are handled throughout the Dutch governance funnel (Interview Alfa, Bravo, Delta, 2025).

To structure the Dutch case analysis, this chapter distinguishes the following planning phases:

- Strategic marine spatial planning and area designation (North Sea Programme / MSP)
- Roadmapping and parcelling (Roadmap *Wind op Zee*: subdivision into “kavels”)
- Project-level consenting (NRD scoping, EIA/MER evidence, *kavelbesluit*)
- Tendering, construction, operations and monitoring

This early integration is partly the result of how Dutch governance evolved. In the early years of offshore

wind, development was largely permit-driven, with limited spatial steering and thin distance rules (e.g., 500 meters). When permitting opened, an overload of initiatives created spatially overlapping claims, legal disputes with ports and oil companies and uncertainty for both developers and government. This experience, including conflict with shipping and oil and gas interests, generated pressure to redesign the governance model. The Offshore Wind Energy Act marked a transition toward a more state-steered approach. Wind energy areas are designated first and project-level site decisions (*kavelbesluiten*) are then developed within those areas (Interview Delta, personal communication, 2025). A key takeaway of this thesis is that the current Dutch model is designed to prevent permit chaos and to avoid navigational safety conflicts emerging only late in the process, when changes are most costly.

At the strategic level, the Program North Sea (*“Programma Noord Zee”*) designates offshore wind zones/search areas. It integrates navigational safety considerations in maritime spatial planning, for example by anchoring assessment frameworks for safe distances between wind energy areas and major shipping routes and routing measures. These high level choices establish the boundaries in which later project decisions must operate and create the first safeguard that wind farm development does not directly conflict with main traffic flows.

After spatial planning, the Ministry of Climate and Green Growth, responsible for offshore wind development, produces a Roadmap Wind op Zee (Routekaart). It sequences which wind energy areas will be developed when, and aligns this with grid connection planning and other offshore uses. For shipping safety, this phase is relevant because early area studies and safety assessments (commissioned by government agencies and reviewed within lenW) inform whether areas can proceed as planned or require adjustments before they become further “locked in”(Interview Alfa, personal communication, 2025). In parallel, this stage also includes plotting/parceling. Wind energy areas are subdivided into project sites (“kavels”), and preliminary layouts are drafted based on expected power yield. This matters for safety because traffic-risk assessments are configuration-dependent and early layout choices can already shape later evidence needs.

At project level, permitting is structured around the Environmental Impact Assessment (EIA/MER) process and the *kavelbesluit* (site decision). The first formal step is the *Notitie Reikwijdte en Detailniveau* (NRD), published as a draft and then finalised. The NRD functions as a scoping and traceability instrument. It specifies the “bandwidth” of design parameters to be assessed (e.g., turbine dimensions, spacing, foundation type) and the effect categories that must be investigated, explicitly including maritime safety (Interview Alfa, personal communication, 2025). This ensures that shipping safety considerations are formally integrated in the evidence-generating process before permit conditions are drafted.

Next, the EIA (MER) produces the project-specific safety evidence base. In the Dutch process, this includes technical and risk studies that assess impacts on existing uses such as shipping and fisheries. This can be used to justify spatial design choices (e.g., buffers, layout constraints, or corridor requirements). The permitting structure also contains multiple formal consultation windows: stakeholders can submit views on the NRD and on draft site decisions and studies, and sectoral concerns about navigational safety can be translated into conditions attached to the site decision (for example, safety corridors or turbine layout constraints).

The site decision itself proceeds through two decision moments, draft site decision and final site decision, after which stakeholders can still appeal to the decision. A key governance feature here is that other ministries co-sign the site decision. Interview data highlight that this co-signing is not symbolic but a formal requirement (“without their signature, no site decision”). In practice, this creates a clear stage where maritime safety concerns must be resolved in a defensible way before the permit can be finalised. Once the *kavelbesluit* is final, RVO organises the tender and developers enter the process under predefined spatial and safety conditions.

Finally, the downstream phases of tendering, construction and operations matter for shipping safety, because they operationalise the conditions set upstream. Construction and operations are shaped by the predefined spatial/safety conditions and by monitoring and emergency response arrangements that increasingly focus on traffic around wind farm zones. In this way, shipping safety is not only assessed during planning, but carried into operational governance through surveillance and response capacity.

5.1.2. Stages and lock-in points

The Dutch process contains several stages where shipping safety-relevant choices become more difficult to change. A first lock-in occurs at plan level. Once wind energy areas are appointed in the North Sea Programme and aligned through route-mapping, later decisions largely concern optimising within the designated area rather than reopening fundamental spatial choices. For shipping safety, this plan-level stage is where the strongest avoidance mechanism operates. Major conflicts with main traffic flows are prevented upfront and baseline distance and routing principles are embedded before projects enter detailed design.

A further lock-in is financial and institutional rather than spatial. Interviews suggest that spatial designation has increasingly become politically credible only when accompanied by clarity on who pays for the associated safety mitigation and operational measures. In practice, this creates a “funding gate”. Designating new wind energy areas implies downstream commitments (e.g., monitoring, emergency response capacity) that require budgeting by the state. However, interviewees also described that political cycles can temporarily decouple these elements, spatial reservation may proceed while funding decisions lag due to cabinet elections or broader budget uncertainty. This decoupling does not necessarily stop spatial planning immediately, but it can undermine the feasibility and legitimacy of later stages, because the safety package that makes a designation acceptable is no longer guaranteed upfront.

At the same time, the Dutch system seems to push forward a range of issues to the site-decision stage. Only a limited set of spatial constraints is fully in the first stage. Many safety details, such as the exact translation of distance frameworks into an area-specific configuration, how traffic risks are evidenced and how mitigation is formulated, are addressed through the NRD/EIA and the conditions of the site decision.

This push-forward logic is reinforced by the formal design of the site decision procedure. There are four legally required public moments (draft NRD → final NRD → draft site decision → final site decision). These moments create multiple opportunities for stakeholders to raise navigational safety concerns that can become permit conditions.

From a shipping safety perspective, the most consequential lock-in point is typically the transition from scoping and evidence production into formalised draft permit conditions. Once a draft site decision and accompanying studies are published, significant changes become costly for three reasons:

1. If spatial layouts or assumptions shift after the NRD/EIA work has begun, safety studies and related assessments may need to be repeated for the updated configuration. This can be particularly relevant when the spatial layout of sites is refined in response to other decision criteria (e.g., grid alignment or yield optimisation), because safety evidence is configuration dependent.
2. Delay risks from formal participation and appeal. The multiple consultation windows and the ability to appeal final site decisions introduce procedural time risk. This matters for shipping safety because contested or ambiguous safety issues are precisely the types of issues that can be raised during consultation or litigation and translated into additional conditions or adjustments.
3. Lastly, interview evidence suggests a limit to exhaustive safety analysis. While maritime safety functions as a prerequisite in permitting, demonstrating risk effects and the proportionality of measures can be difficult. Quantification is often uncertain, yet expanding assessment scope indefinitely is not feasible because it increases costs and slows the process. As a result, governance tends to rely on bounded evidence (models plus expert judgement) and on defensible “reasonableness” in the conditions attached to the *kavelbesluit*, rather than aiming for complete elimination of uncertainty (Interview Bravo, personal communication, 2025).

In short, the Netherlands combines early lock-in through spatial designation with project-level specification through evidence and conditions. This funnel explains why safety influence is highest at the MSP/area-designation stage and why actors try to avoid late-stage re-openings.

5.2. Policy outcomes and instruments

This section summarises the main safety instruments the Dutch system produces, before explaining why they emerge.

5.2.1. Distances & spatial buffers

A central Dutch preventive instrument is the use of buffers between wind farm areas and major shipping structures. As a default planning rule, the Netherlands applies a minimum distance of two nautical-miles between wind energy areas and (inter)nationally recognised routing measures, anchorage areas and clearways [62]. This buffer preserves manoeuvring space and increases the time available to respond to deviations or engine/steering failures before a drifting vessel reaches the wind farm area.

Importantly, interview evidence suggests that this distance functions as a baseline rather than an unchangeable standard. For specific areas, the buffer can be refined based on site-specific traffic characteristics and incident analyses and adjusted if required to keep the residual risk defensible [62].

5.2.2. Marking and lighting

To safeguard visibility of offshore wind farms for vessels, marking and lighting requirements are regulated in accordance with international recommendations and national adaptations. In the Dutch case, the key governance point is not the technical specification, but that safety requirements are internationally anchored while allowing national preference based tailoring. The IALA Recommendation O-139 offers two marking concepts. Perimeter-only marking, in which the wind farm is treated as a single large navigational structure and only the outermost turbines and corners are fitted with lights and markings. Second, turbine-by-turbine marking, in which each individual turbine is provided with a navigation light. States may select and adapt these concepts based on national risk assessments and maritime traditions. Dutch practice combines international standards with selective reduction of visual clutter. All outer turbines and key corner points are marked and lit in accordance with IALA prescriptions, providing a clear outline of the wind farm boundary. Inner turbines may be equipped with reduced lighting or no navigation lights, as long as the overall visibility and recognisability of the wind farm is preserved [32].

5.2.3. Passage & access rules

Besides keeping wind farms away from major shipping systems, Dutch policy also governs “who may enter” wind farm areas. These passage and access rules show the general safety logic around offshore wind farms. The more predictable and observable traffic is, the easier it is to manage residual risk around fixed infrastructure.

In practice, the Netherlands allows limited passage for small vessels through some wind farms via corridors. Passage is only for vessels below a size threshold (e.g., under 24-45 metres) and carrying AIS, maintaining radio watch and with the expectation that vessels remain on marked routes [47]. The governance rationale is twofold. First, corridors spatially bundle traffic into known lanes, reducing the likelihood of unpredictable movements close to turbines. Second, AIS-based visibility increases the ability of authorities to monitor compliance and detect unpredictable behaviour, which interviewees emphasised as increasingly important.

At the same time, access is constrained by strict prohibitions that protect both security and infrastructure. Anchoring is prohibited within wind farms, including within passage corridors. This restriction functions as a non-negotiable boundary condition. Anchoring can damage cables and foundations and creates stationary obstacles that harm safe navigation [26]. The anchoring ban therefore reduces both immediate navigational hazards and the risk of infrastructure failures.

5.2.4. Multi-use and fishing

Dutch offshore wind policy increasingly frames wind farm areas as candidates for *multi-use* rather than exclusive zones [47]. Allowing activities such as fishing inside or near wind farms reduces the predictability of traffic patterns, raises monitoring and enforcement demands and, especially active fishing, can damage cables.

Interview evidence suggests a notable policy shift in how fishing is treated. Earlier practice was to close the area in and around wind farms (consistent with exclusion as the strongest preventive instrument). More recently, the direction has moved toward “not making fishing impossible” and regulating access through a permit-based regime. In practice they call it an “area passport” approach [46]. Entry and activity are allowed only if an operator can demonstrate he is working in specific conditions (who may enter, what type of fishing is permitted). This shift aligns with a broader move from prohibition to conditional allowance. Fishing becomes allowed if safety and enforceability can be demonstrated.

5.2.5. Monitoring and emergency response measures

Because the Netherlands has limited scope to regulate ship behaviour in the EEZ, interviewees emphasised that safety governance does not end with spatial planning and permit conditions. It is complemented with operational measures that aim to detect hazards early and react in time. This operational layer becomes more important as offshore wind density increases and as residual risk cannot be eliminated through planning alone (Interview Charlie, personal communication, 2025).

Traffic monitoring

Traffic monitoring and information services are an important preventive instrument. In the Netherlands, AIS carriage is mandatory for most vessels [49]. Vessel Traffic Services (VTS) are provided by the Netherlands Coastguard and port authorities in dense traffic areas, especially port approaches (e.g., Rotterdam and Amsterdam). VTS centres monitor vessel movements and provide navigational information and warnings to reduce collision risks.

Interview evidence and recent practice indicate a shift. Monitoring is no longer only concentrated around ports and main routes, but increasingly focused around offshore wind infrastructure as well. In response to the growing density of infrastructure at sea, in 2025 the Coastguard introduced wind-farm-oriented monitoring under the label *VTMon*. *VTMon* performs 24/7 surveillance in and around wind farm zones by using radar, AIS and other sensor data to identify irregular behaviour (e.g., loss of speed, unusual course changes or drift towards turbine fields) [50]. This can trigger operator action such as contacting the vessel, issuing advice or mobilising response vessels.

Emergency response capacity

Reactive measures aim to limit impact once a hazardous situation occurs. A Dutch instrument is the deployment of ERTVs. These are powerful vessels at high readiness to assist ships with engine or steering failures that may drift towards wind farms or the coast. The Netherlands has four ERTVs under Coastguard coordination, positioned to reach critical locations quickly and provide help by pulling a vessel away from danger [39]. Search and Rescue capabilities complement towing by focusing on human life. SAR operations are coordinated by the Coastguard and include helicopters for offshore rescue from vessels or turbine platforms.

Taken together, these measures illustrate the Dutch pattern highlighted by interviewees. Preventive governance (planning and permit conditions) is complemented by an operational safety strategy built around early detection and timely intervention in a domain where not all behaviour can be controlled through national rules alone (Interview Bravo, personal communication, 2025).

5.3. Explaining The Netherlands outcomes using the analytical framework

This section explains the Dutch outcomes through the four analytical dimensions, focusing on the mechanisms that will be compared to the United Kingdom.

5.3.1. Vertical coordination

In the Dutch EEZ, limited control over shipping pushes safety governance toward the instruments the state *can* control. Plan-led spatial designation, legally defensible site-decision conditions and operational monitoring/response. This dependence increases as offshore wind expands toward borders.

Vertical coordination concerns how safety governance in Dutch offshore wind is influenced by multi-level rule systems. It is shaped by the interaction between international maritime organisations, European and national regulation and Dutch implementation in the EEZ. For shipping safety, the EEZ is a complex area. It is crucial for the next step of offshore wind expansion, but it does not offer the same degree of unilateral regulatory steering that states have on land. Interviewees emphasised that maritime law and international frameworks are leading in the EEZ, which constrains the measures and regulations the Netherlands can introduce or enforce and makes policy change dependent on coordination beyond the national level (Interview Bravo, personal communication, 2025).

This multi-level setting also structures *when* spatial and safety governance can be updated. At EU level, the Maritime Spatial Planning (MSP) Directive requires member states to maintain and periodically revise maritime spatial plans. In the Netherlands this translates into cyclical revision of the *Program North*

Sea as part of the National Water Programme. Interviewees stated that the Dutch update rhythm is structured through a national planning cycle, creating recurring revision (Interview Delta, personal communication, 2025). For shipping safety governance this matters because it creates a built-in tension between *regulatory stability* (predictability for shipping and developers) and *adaptation* (the need to respond to rapidly evolving offshore wind scale, vessel sizes, and traffic patterns). In practice, spatial steering opportunities are concentrated in these revision windows, while in-between adjustments must be made through more incremental instruments (e.g., site-decision conditions and operational measures; see sections 5.1-5.2).

Empirically, Dutch shipping-safety governance reflects a two-layer design that allocates different decisions to different levels, while leaving core navigation rights and routing rules anchored internationally. The plan layer (*North Sea Programme*) performs the most vertical form of steering. It designates wind energy areas and avoids internationally anchored navigation systems. This is where the state can exercise the strongest preventive influence, by minimising spatial conflicts before projects enter detailed design. The project layer (NRD/EIA and *kavelbesluit*) operationalises the plan-level areas into site-specific and binding conditions (e.g., layout-related constraints, safety corridors or monitoring-related requirements). This division reflects mandate and delegation: the state uses high level spatial planning to reduce the likelihood of major shipping conflicts, while project-level instruments translate that into defensible, case-specific safety conditions that can withstand appeal (Interview Alfa; Interview Bravo, personal communications, 2025). To avoid duplication, this section focuses on what this two-layer structure *does* in governance terms (mechanisms), while the process sequence and concrete instruments are described in Sections 5.1–5.2.

A recurring implication of this vertical coordination challenge is that the Netherlands can be expected to rely on a combination of spatial planning and permit conditions (preventive governance) and monitoring and response capacity (operational governance), rather than assuming that shipping behaviour can be fully controlled through national prescriptive rules in the EEZ. This is consistent with interview evidence that spatial planning is viewed as the strongest preventive instrument available to the state, while downstream safety performance increasingly depends on early detection and timely intervention through mobile resources and monitoring systems (Interview Bravo, personal communication, 2025). This “EEZ constraint → instrument choice” logic is a core mechanism linking vertical governance structure to observed safety outcomes.

Standards gaps and interpretive space

Interviewees also pointed to a practical gap between the governance need created by rapid offshore wind expansion and the maturity of available international frameworks and standards. Even where international guidance exists, categories may be strict or narrowly defined for emerging offshore contexts. This creates interpretive space: actors must decide whether a new practice fits within an existing label (and associated expectations) or whether it must initially be framed as something new. A concrete example is wind-farm-oriented monitoring. Interviewees explained that new monitoring practices were initially framed in ways that avoided triggering international category expectations too early (e.g., separating VTMon from “VTS”), precisely because labels carry implied responsibilities and expectations (Interview Bravo, personal communication, 2025).

This illustrates a form of innovation under constraint. Such temporary concepts can function as boundary objects. They are recognisable enough to coordinate action domestically and internationally, while remaining flexible enough to evolve within shared understanding and international frameworks. In governance terms, it provides a temporary bridge between what is urgently needed for safety management in practice and what is formally stabilised in international regimes.

Vertical coordination and responsibility allocation

A final vertical coordination implication concerns responsibility and the burden of proof. Because vertical constraints limit national ability to directly regulate ship behaviour in the EEZ, risks must be managed through the subset of instruments the Netherlands can control. This makes attribution (“who causes the risk”) politically consequential, since it determines who is expected to adapt, fund, or justify safety measures within the constrained governance space. Interviewees described this as producing a dynamic where actors may frame others as the “source” of emerging risk (e.g., offshore wind expansion creates constraints for shipping or shipping behaviour creates risk around fixed infrastructure). In such

a setting, demonstrating that a risk increase is imputable to specific changes and that proposed measures are proportionate becomes part of the governance challenge. This increases the importance of traceable evidence (models, expert judgement, risk studies) in justifying safety measures within the institutional space the Netherlands does control (Interview Alfa; Interview Bravo; Interview Charlie, personal communications, 2025).

Given the structuring role of international frameworks and the slow pace of formal change in maritime law, safety governance depends on instruments that can operate within this constrained space, including stable standards, monitoring requirements and maintained operational response capacity. (The post-Julietta D / post-OVV accountability effect is discussed in Mini-case 5.5.)

Cross-border dependence and coordination (SN17 example)

Cross-border coordination becomes more important as offshore wind expands toward border areas. Interviewees explained that shipping flows and routing needs do not stop at national boundaries. This means that national spatial designation and site conditions can only partly manage risk if neighbouring states develop wind farms in the same area under different assumptions or timing (Interview Alfa; Interview Charlie, personal communications, 2025).

A concrete illustration is provided by the planning of wind energy *area 6/7*. Interviewees showed that the Dutch side allocation and parcelling of this area was initially expected to occur very close to a planned German offshore wind development on the other side of the border. In that configuration, the remaining space would have constrained (and potentially blocked) key ferry routes connecting the northern Dutch and German coast (Interview Alfa; Interview Charlie, personal communications, 2025). The issue was ultimately resolved through adjustments during planning and coordination, illustrating that some safety outcomes depend on negotiated cross-border alignment instead of purely national optimisation.

This also illustrates how vertical coordination increasingly extends beyond international frameworks to practical cross-border routines. Interviewees noted that neighbouring countries are now consulted during spatial planning, so transboundary routing implications can be identified earlier. In addition, neighbouring states can participate through formal procedures at the defined moments in the site decision process (using formal appeal channels once decisions are finalised). This improves early identification of cross-border constraints and reduces the chance that routing conflicts are discovered only after site configurations and assessments have already become locked in (Interview Alfa; Interview Charlie, personal communications, 2025).

5.3.2. Horizontal coordination

In the Dutch case, maritime safety influence is institutionalised through co-signing and structured arenas, but it operates through “evidence politics”. Safety claims must be translated into defensible, proportionate measures and most outcomes are shaped before formal lock-in through informal pre-alignment and escalation routines.

Horizontal coordination concerns how maritime safety is negotiated and aligned across sectors and organisations involved in offshore wind planning. In the Dutch case, this is not only a matter of “stakeholder participation” in a general sense, but a structured way of coordination across multiple arenas in which different interests (shipping, offshore wind, ecology, fisheries, mining, grid development) are weighed against each other. Consistent with the boundary-condition framing introduced above, maritime safety is a boundary condition. *“If maritime safety concerns cannot be resolved in a defensible way, projects are unlikely to proceed”* (Interview Delta, personal communication, 2025). However, interviewees also stressed that this boundary condition is not endless. Safety demands must remain plausible and substantiated, which makes coordination partly an exercise in translating concerns into evidence and proportionate measures.

Formal coordination arenas

Formal horizontal coordination occurs through legally and procedurally defined arenas that structure who is involved, when and with what status. First, the *Program North Sea* process functions as a central integration mechanism at plan level. It provides the formal basis for designating wind energy areas, and it brings together interdepartmental actors. Interview evidence indicates that shipping interests can shape outcomes at this stage, including instances where search areas or designated areas were

dropped because conflicts with shipping were considered too significant (Interview Delta, personal communication, 2025). Plan-level coordination functions as an “avoidance filter” that reduces the probability of late-stage conflict.

Second, at project level the NRD/EIA and *site decision* procedure creates formal review moments and consultation rounds. These moments matter less because they enable “new bargaining”, and more because they translate cross-sector concerns into a traceable record and into binding conditions (see section 5.1 for the procedural process). They also provide a formal channel through which contested issues can be escalated, creating a procedural incentive to resolve safety concerns before finalisation.

Third, formalised advisory and stakeholder platforms support coordination between government and sectors. Interviewees referred to the Shipping Advisory Group North Sea (SAN) as a forum where proposed decisions and emerging plans are discussed with shipping representatives. In addition, the North Sea Consultation (NZO) functions as a broader stakeholder platform where multiple sectors are represented and can collectively signal concerns, even if it is not a formal decision-making body. Together, these arenas provide recurring coordination moments in which maritime safety concerns can be raised, checked against other interests, and, when necessary, translated into conditions for planning and permitting (Interview Delta, personal communication, 2025).

Informal coordination and early-phase influence

While formal arenas provide structure and legitimacy, interview evidence suggests that much of the substantive bargaining and design work occurs in informal coordination processes. These include bilateral contacts with sectors, iterative working-groups with policy officers and experts and repeated “pre-alignment” before formal documents are published. One interviewee described this as the place where the “creative planning process” happens. Parties can exchange knowledge, test alternatives and adjust proposals in an iterative way, which is harder to do once positions have been written down in formal consultation documents (Interview Delta, personal communication, 2025).

This informal “cooking process” matters because early phases are where the big strokes are still possible (Interview Bravo, personal communication, 2025). Before spatial choices become locked-in, informal coordination can influence which areas are explored, which variants are developed and which risks are treated as decisive versus manageable. For shipping safety, this helps explain why safety is often experienced as “entering early” in practice. Conflicts with major shipping flows tend to be addressed upstream through informal alignment, rather than being left to the end of permitting. The implication is that horizontal coordination is not only about reacting to formal consultation feedback, but about shaping the design space before it reaches the formal stages.

Formal veto logic and the reasonableness constraint

Key actors can effectively block progress if boundary conditions are not met. Interviewees repeatedly referred to maritime safety as a prerequisite and to co-signing as a concrete institutional mechanism. Other ministries (Infrastructure Water & Management, Economic Affairs, Climate & Green Growth) must co-sign site decisions. In practice a site decision cannot proceed without their agreement. This creates leverage for safety actors and increases the likelihood that safety issues are resolved before realisation of projects.

At the same time, this veto capacity is constrained by a reasonableness requirement. Interview evidence emphasised that safety actors cannot simply “dig in their heels”. Measures must be plausible, defensible and proportionate, especially when they come with significant costs or delays. This makes horizontal coordination partly a translation problem. Safety concerns must be translated in ways that other actors can accept as justified, which in turn increases demand for evidence (risk models, expert judgement) (Interview Bravo; Interview Charlie, personal communications, 2025). In other words, the coordination system protects safety as a boundary condition, but it does not eliminate negotiation about what “safe enough” means and what measures are proportionate.

Despite strong working-level coordination, the most difficult trade-offs are ultimately resolved at political level. When choices have major distributional consequences (e.g., high mitigation costs, tighter spatial constraints or delays), escalation occurs through DG-level alignment. If needed, a ministerial meeting where the decision is made and political priorities shape the final outcome (Interview Delta, personal

communication, 2025). This raises the value of quantified and traceable evidence in horizontal coordination. Models, risk calculations and expert judgement translate safety concerns into arguments that are legible to ministers and defensible in public and parliamentary accountability. This provides mandate for costly or restrictive measures. At the same time, it implies a risk. If safety influence can be influenced by shifting political priorities or incident-driven attention, its boundary-condition status can weaken over time. It is therefore not less important to institutionalise safety through stable procedures (co-signing and stages), standardised assessment requirements and predictable funding for mitigation and operational capacity.

Polycentric governance as weakness and strength

Interviewees described Dutch North Sea governance as polycentric. Multiple ministries, agencies, and sectoral actors have partial authority, different objectives and different resources. This fragmentation can be a weakness, because it risks misalignment in timing, increases coordination overhead and goals can differ (safety vs. development targets). For example, operational maritime safety depends heavily on the Coastguard, yet the Coastguard is subject to multiple principals (IenW, Defence, Justice and Security and others). This complicates prioritisation and makes it harder to steer capacity solely from a shipping-safety perspective (Interview Bravo, personal communication, 2025).

At the same time, polycentric governance can function as a strength in the form of checks and balances. Because multiple actors have voice and influence, radical shifts proposed by one party can be constrained by others with aligned interests. Interviews emphasised that coalition dynamics matter. Safety actors may not always be able to win alone, but can build alignment with other stakeholders (e.g., infrastructure protection and security interests) to strengthen their position. This coalition potential stabilises safety outcomes, but at the cost of slower coordination and higher transaction costs

Dispute, negotiation and alignment

Horizontal coordination is characterised by recurring dispute, mostly around space allocation and the distribution of costs and constraints between sectors. Interview evidence suggests that shipping safety is rarely contested as a principle, but becomes difficult when it translates into spatial exclusion, additional mitigation costs or stricter operational restrictions. A recurring coordination pattern is *push-forward* [52]. Politically loaded commitments are made upstream, while distributive questions about risk allocation, enforceability and who pays for monitoring or response capacity are moved downstream to later permitting and operational arrangements (see Section 5.2.4). This keeps flexibility under uncertainty, but it also means that the hardest trade-offs are settled closer to implementation, when project configurations and responsibilities are concrete.

This is visible, for example, in multi-use ambitions. While multi-use can be sustained at plan level, interviewees describe how feasibility is often constrained downstream by the interaction of safety requirements, business-case impacts (e.g., insurance) and more recent security considerations. For instance, Interviewee Alfa noted that despite the stated ambition for active fishing within wind farms, these combined constraints make active fishing inside wind farms difficult in practice (Interview Alfa, personal communication, 2025).

5.3.3. Timing & safety-mode (Safety-I vs Safety-II)

Building on the process overview in Section 5.1, this section interprets what early safety entry implies for timing and the dominant safety paradigm. The governance challenge is less “whether safety is included” than *how* it is substantiated under uncertainty and before formal lock-in. The Dutch approach is anchored in Safety-I boundary conditions, while Safety-II practices increasingly complement this baseline to manage uncertainty and residual risk as offshore wind scales.”

Where maritime safety enters the process

Maritime safety enters the Dutch process early, but its influence is distributed across the funnel. The strongest preventive effect occurs upstream through plan-led spatial steering. This filters out locations that would directly conflict with major traffic flows. Downstream, the site-decision process shifts the focus from whether an area is acceptable to how safety is evidenced. It translates into proportionate conditions and must be defended in consultation and appeal. This creates a timing logic in which safety is institutionalised early as a recurring criteria, yet becomes most contested and consequential

around the transition from scoping/evidence production to draft permit, where changes are costly and procedurally risky.

Interviewee Alfa described maritime safety as a standard topic in the NRD “bandwidth” list. It is explicitly included alongside ecology, animal protection and other themes. This institutionalises safety early in the evidence-generating phase. The NRD defines what must be studied, which means safety is integrated before permit conditions are drafted. The detailed process roles and instruments are described in Sections 5.1–5.2.

Importantly, early entry also reflects the iteration logic discussed in Section 5.1.2. Once draft site decisions and studies are published, changes become costly because evidence is configuration-dependent and procedural windows introduce delay risk. This creates strong incentives to resolve fundamental safety issues early, before formal lock-in.

This timing logic is reinforced by learning in practice. Interviewee Bravo noted that in earlier phases of offshore wind development, maritime safety was less systematically involved and risk knowledge was weaker. As a result, some existing wind farms were developed in locations that later proved operationally suboptimal from a shipping-safety perspective. They now require additional measures and negotiation downstream. In other words, early safety involvement functions as a preventive mechanism. It reduces the likelihood that the system must rely on costly, reactive mitigation once spatial choices have become locked-in.

Safety framing in practice

Building on the boundary-condition framing introduced at the start of this chapter, interviewees emphasised that the key governance challenge is defining and defending ‘safe enough’ under uncertainty. This framing matters for timing, because it shifts safety from being a competing interest to being a threshold that must be satisfied before other trade-offs are finalised. In practice, interviewees linked this to co-signing and the expectation that a project without a defensible safety settlement is likely to face delay or failure.

At the same time, “safety as a boundary condition” does not eliminate negotiation; it changes what negotiation is about. Disputes are often less about whether safety matters than about what “safe enough” means under uncertainty and which measures are proportionate and defensible. Two issues recur:

1. Safety definition vagueness: “Safety” is not a single fixed metric. Actors may interpret acceptable risk differently depending on their role (safety regulators, spatial planners, project developers, ports/shipping). This means translating safety becomes important for regulators. It means formulating conditions that are understandable across communities (technical experts, policy generalists, ministers) (Interview Charlie, personal communication, 2025).
2. Burden of proof and quantification pressure: Several interviewees described how costly measures (or measures that affect the business case) increase demand for quantification. Yet quantification is difficult because probabilities and consequences are uncertain and mitigation effects are not always captured well in modelling (Interview Delta, personal communication, 2025). As a result, safety integration depends not only on “being present,” but on whether risks and measures can be substantiated in ways that are credible and politically actionable.

Interview evidence suggests this challenge is reinforced by the static nature of key policy instruments and guidance. Frameworks (e.g., the program North Sea) are updated in multi-year cycles, which can lag behind rapid changes in offshore spatial density, technology and traffic patterns. As a result implementing organization, especially smaller actors with limited analytical capacity, often rely on older “official” guidance as a defensible reference point. This creates a risk that safety governance becomes reactive or lags behind because updating norms and targets requires external validation and takes time (Interview Bravo, personal communication, 2025).

This creates an important nuance for this thesis: early procedural inclusion does not imply complete safety knowledge. Safety can be integrated early as a veto point while still being constrained by limited data, evolving traffic patterns and imperfect analytical tools. In this sense, the timing is early, but robustness depends on the maturity of evidence and the capacity to act despite uncertainty.

Safety paradigm: from Safety-I to emerging Safety-II elements

Interview evidence suggests that Dutch maritime safety governance around offshore wind is best characterised as a hybrid rather than Safety-I or Safety-II. Safety-I remains the baseline in the way safety is framed and assessed. In practice, this functions as maintaining safety at (at least) the current level is the reference state, and deviations require justification and mitigation. Projects should not proceed if a safety decrease cannot be ruled out or defensibly mitigated. This aligns with a Safety-I orientation focused on preventing accidents and controlling known hazards through spatial avoidance, formal assessments and enforceable permit conditions.

At the same time, interviewees described increasing pressure on a purely Safety-I approach as offshore wind scale-up creates more interactions and future conditions are uncertain. In response, Safety-II is becoming more visible in specific initiatives and among specific actors. Interviewee Bravo described scenario-based work that explores plausible futures and tests whether current requirements and resources remain sufficient. This is shifting emphasis from proving risks on historical data toward anticipation and preparedness (Interview Bravo, personal communication, 2025). Interviews also pointed to learning from near-misses and successful interventions (“what goes right”) as inputs for strengthening preparedness. Finally interview shows a shift to operational resilience through monitoring, early detection and timely response capacity as a way to manage residual risk in the EEZ (Interview Alfa; Interview Bravo, personal communication, 2025) (see Section 5.2.4).

A key implication that showed up in the interviews is that Safety-II practices help justifying costly measures under conditions of uncertainty. Interviewees noted that expensive interventions (e.g., additional monitoring capacity, emergency towing capability) raise the burden of proof and intensify demands for justification. Especially when they affect the offshore wind business case, which is already very weak nowadays. Because major incidents are infrequent, and therefore difficult to use as a stable metric, near-misses and scenario-based analyses become politically and administratively important sources of legitimacy. They can support the argument that risks are changing structurally, relying on accident statistics is insufficient, and that investment in capacity is justified to prevent rare but catastrophic outcomes.

Finally, interviewees linked shifts in mandate and priority to incident attention (pre–Julietta D → post–OVV). To avoid repetition, this temporal “window of influence” mechanism is elaborated in mini-case 5.5. The key point here is that Safety-II practices provide the governance tools and evidence logic that helps translate heightened attention into capability and oversight.

5.3.4. Dual-layer compliance and evidence practices

Dutch maritime safety governance around offshore wind operates through a dual-layer compliance structure. A prescriptive baseline that sets non-negotiable boundary conditions and a performance/evidence layer in which actors must substantiate that residual risk remains acceptable through assessment, monitoring and response capability. This duality reflects the EEZ constraint: the Netherlands cannot fully control ship behaviour through national rules alone (Interview Bravo; Interview Delta, personal communications, 2025).

Prescriptive baseline layer

At baseline level, compliance is organised around hard constraints and minimum requirements that structure what may proceed. Interviewees repeatedly framed shipping safety as “strictly conditional” in spatial planning. Certain configurations are treated as unacceptable regardless of trade-offs, because they create predictable conflict with main traffic flows or internationally anchored routeing (Interview Delta, personal communication, 2025). In the current regime, this baseline is primarily created upstream through plan-led zoning and then laid down downstream through binding site-decision conditions. They define where wind farms may be placed and codify minimum spatial/safety constraints that developers must accept as given.

Importantly, this baseline layer does not remove all discretion, but it sets the minimum of what must be respected before optimisation is even considered. In practice, this includes avoidance of major shipping systems, baseline distance principles and restrictive rules about access. Because safety actors are formal co-signatories of site decisions, the process contains an embedded veto point if baseline conditions are not met (Interview Alfa; Interview Bravo, personal communications, 2025). This

is the prescriptive function of the dual-layer structure. It creates predictability and prevents reopening of fundamental constraints at every project.

Performance and evidence layer

Beyond baseline rules, interviewees described a second layer where compliance is demonstrated through evidence and operational performance rather than fixed prescriptions alone. Here, the central question is not “did we follow the rule?” but “is the risk acceptable in this specific context and are mitigation measures proportionate?”. This is where modelling, expert judgement and operational readiness enter the governance process as assurance mechanisms.

A clear example of this second layer is the increasing use of “allowed if” logic in conflict domains (e.g., multi-use and fisheries access). Rather than relying only on just prohibitions, acceptability depends on whether a defensible safety case can be shown and verified through enforceable conditions and monitoring capacity (see Section 5.2.3).

A key interview insight is that the evidence base itself is bounded and imperfect. For example, interviewees noted that traffic-risk analyses can robustly estimate incident probabilities, but that consequences (minor damage versus fatal outcomes) are not yet well captured. This makes “risk = probability × consequence” analysis difficult in practice (Interview Delta, personal communication, 2025). Interviewees also highlighted that models do not automatically account for mitigation that prevents incidents (e.g., towing intervention). This means quantitative outputs must be interpreted in combination with qualitative judgement and assumptions. As a result, Dutch governance relies on simulation calculations, expert sessions (including sector expertise) and comparative reasoning across locations to build a defensible safety case (Interview Delta, personal communication, 2025). In governance terms, the performance layer is therefore not “purely quantitative”. It is a practice that combines bounded modelling with expert interpretation to justify proportionate measures.

This performance layer also extends into operations: safety assurance increasingly depends on monitoring and timely intervention, early detection of abnormal vessel behaviour and the ability to deploy response vessels quickly enough to prevent incidents. Interviewees mentioned the need for new data streams and indicators, because low incident frequency makes classic outcome metrics (e.g., number of accidents) a weak steering signal. Instead, governance shifts toward monitoring performance (what is detected, how fast actors can respond and whether interventions succeed) as part of safety assurance in an expanding and changing North Sea. (Interview Bravo; Interview Delta, personal communications, 2025).

Learning cycles and policy evolution

Finally, interview evidence suggests the dual-layer structure is not static: both layers have hardened over time and are still evolving. Baseline requirements became stronger as the governance regime shifted toward designated areas and tighter spatial planning at national level. In parallel, the evidence/performance layer increased in ambition. Interviewees described increasing reliance on scenario thinking, expert consultation and learning from near-misses and successful interventions as ways to justify and refine expensive safety capacity (Interview Bravo; Interview Charlie, personal communications, 2025). This change links the dual-layer structure to the broader shift discussed in Section 5.3.3. Safety-I boundary conditions remain central, while Safety-II practices (learning, adaptation, capability building) increasingly provide the logic for keeping compliance meaningful over time.

However, interviewees also noted vulnerabilities in this evolution. Scarce nautical expertise, limited ability to quantify consequences and political or budgetary dynamics. This reinforces the governance implication of the dual-layer model: formal baseline rules and plan-level designation are necessary but insufficient on their own. Safety robustness depends on whether the performance layer is continuously resourced, monitored and updated, so that compliance remains meaningful as offshore wind scale and operational conditions change (Interview Bravo; Interview Delta, personal communications, 2025).

5.4. Mini-case: From fragmented permitting to plan-led marine spatial planning

This mini-case shows how the Netherlands moved from permit-led conflict to plan-led steering, an upstream shift in where safety is stabilised. Marine spatial planning in the Netherlands is more than offshore wind and includes activities such as sand extraction, shipping routes and nature areas. However, offshore wind has increasingly acted as the main driver of spatial change due to its growing footprint and long-term targets. A key trigger for redesigning the Dutch system was the combination of an expanding interest in offshore wind and a regulatory setup that relied on a limited assessment framework. In the late 2000s, this framework included only a small set of spatial rules, such as a minimum distance to shipping of approximately 500 metres, together with similar distance-based rules for other offshore infrastructure. When subsidies became available for offshore wind, developers were incentivised to secure permits. They preferred areas close to the coast as possible, because nearshore locations were often perceived as economically attractive. This created strong competition for the same spaces and set the stage for conflict.

5.4.1. Breakdown of the old approach

Under the permit-first approach, developers could submit permit applications that had to be assessed against the existing policy rules. Because stricter safety distances were not formally embedded in policy, Rijkswaterstaat (RWS)) had no grounds to refuse applications based on growing safety concerns. As a result, a very large number of initiatives entered the system in a short period, creating an administrative overload and a lot of spatial conflicts. Ports and shipping actors in particular challenged the adequacy of the 500-metre distance. Similar tensions showed up around oil and gas platforms, where obstacle-free zones and helicopter access required greater spatial buffers than the existing framework reflected.

This dynamic caused two effects. First, it generated extensive assessment work for permits that were unlikely to be realised, since only a subset of initiatives would ultimately receive subsidy support. Second, it created uncertainty due to legal questions. Decisions were repeatedly challenged in court, meaning both authorities and developers had no clarity about which projects would proceed and under what conditions. In practice, safety and spatial trade-offs were addressed late in the process, after positions had hardened and after applications had already created a “funnel” effect. Once projects were in the system, steering became difficult and conflict resolution shifted from planning to litigation.

5.4.2. Reform and the new sequence

Interviewees describe this period as a tipping point that led to a redesign of offshore wind governance and its relationship to MSP. The core reform was to change the sequence of decision-making. Instead of letting projects propose sites first, the state would first designate wind energy areas through the marine spatial planning process. They would allow development only within these areas. This system was embedded in the Offshore Wind Energy Act, which formalised a system wide approach in which spatial choices are made upstream and translated into site decisions and subsequent tenders [48].

Besides this change, roles and responsibilities were also reallocated. Where RWS had previously been the competent authority handling permits, competence for offshore wind site decisions shifted to the energy ministry (EZ/KGG), while RWS retained a central role in preparing site decisions. Initially through the “structural vision” and later the marine spatial planning map under the North Sea Programme, wind energy areas were designated and later specified into more concrete site decisions. This plan-led system has supported successive scale-up phases [34].

5.4.3. Mechanism illustrated: upstream stabilisation through plan-led sequencing

This mini-case illustrates a sequencing mechanism. When offshore wind development was permit-led, maritime safety concerns surfaced late, after developers had already selected preferred sites and invested in applications. This created lock-in and moved conflict resolution into litigation. The reform reversed this sequence by moving spatial choices upstream into marine spatial planning and site allocation. By designating wind energy areas first and developing site decisions within those areas, the Dutch system created an early avoidance filter that reduces the likelihood of direct conflict with main

traffic flows and turns maritime safety into a precondition for progressing to project-level decisions.

5.4.4. Why it mattered: reducing late-stage lock-in and creating a defensible basis for decisions

Under the old approach, the thin prescriptive baseline (e.g., the 500 m distance rule) limited the ability of authorities to refuse or reshape projects on safety grounds, even when perceived risk increased. This produced two reinforcing problems. First, administrative overload from having to assess too many initiatives that would never be realised. Second, it prolonged uncertainty as disputes escalated into appeals and court cases. By shifting to a plan-led model embedded in the Offshore Wind Energy Act, the state created a clearer mandate for upstream spatial steering and a more defensible basis for project-level decisions. Fundamental trade-offs are settled earlier, while later permitting focuses on evidence and conditions within predefined spatial boundaries rather than on reopening location choices.

5.4.5. Bridge to synthesis

This mini-case underpins Proposition 1 in the synthesis chapter. In the Netherlands, plan-led marine spatial planning stabilises shipping safety upstream by filtering spatial options early and reducing the risk that safety conflicts emerge only after costly project-level lock-in.

5.4.6. Outcome and relevance for OWF scale up

The transition from permit-first applications to plan-led spatial planning shows how the Dutch system adapted as offshore wind ambitions increased and spatial conflicts intensified. By moving key trade-offs upstream into MSP and site allocation, the system reduced assessment effort, improved predictability and decreased the likelihood that safety conflicts would only surface after projects were already locked into formal procedures. This mini-case therefore helps explain why shipping safety in the Netherlands seems to be treated as a boundary condition that must be addressed early in planning, instead of as an issue that can be resolved later through late-stage project mitigation. This upstream stabilisation reduces late-stage litigation risk and is a core ingredient in the cross-case comparison.

5.5. Mini-case: Julietta D and the OVV report as driver for a more systemic risk approach

This mini-case shows how an incident and independent oversight can create a window in which shipping-safety concerns can translate into mandate, resources and steps toward a more systemic evidence base. The turning point was the “Julietta D” incident (January 2022), followed by the OVV investigation and recommendations (2024).

5.5.1. Trigger: abstract risks become visible

In January 2022, the bulk carrier “Julietta D” encountered problems during a storm, collided with another vessel and struck structures at an offshore wind farm under construction. The incident did not lead to fatalities, but it made the consequences of reduced manoeuvring space and more fixed infrastructures on the North Sea highly visible. Interviews describe this type of accidents as a “catalyst”. It changes a long-discussed, but very abstract concern into a concrete governance problem that is difficult to ignore.

5.5.2. Mechanism illustrated: oversight creates accountability and redefines the risk question

Following the incident, the OVV assessed whether shipping-safety risks related to offshore wind scale-up were sufficiently understood and governed. The OVV concluded that risks were insufficiently known and recommended a different approach. They state the need for a shift toward system-level insight building: modelling and scenario thinking, a realistic and testable safety goal, assessment of measure effectiveness, application across existing and planned wind farms, and periodic evaluation [51]. Interviewees described OVV recommendations as a governance mechanism. They trigger a formal accountability cycle in which ministers must respond and demonstrate improvement, which in turn helps unlock mandate and resources for building a more robust approach (Interview Bravo, personal communication, 2025). This accountability cycle creates a temporary window of influence. Interviewees

noted that incidents and subsequent OVV attention increase political salience, which makes it harder to deprioritise maritime safety relative to scale-up and cost pressures. In practice, this window tends to translate into additional mandate and resources for maritime safety actors. It strengthens their ability to push for earlier intervention and stricter requirements in planning and consenting (Interview Bravo, personal communication, 2025).

5.5.3. Why it mattered: building an evidence loop and a defensible definition of safe enough

Interview evidence suggests that earlier practice relied heavily on a prescriptive baseline (e.g., design criteria and distance-based constraints) complemented by project-level assessments. This provided a workable compliance pathway but did not automatically produce a system picture as offshore wind scales up. In response to OVV pressure and increasing spatial congestion, the Dutch approach is beginning to change along three connected elements. First, actors are strengthening system-level evidence building through traffic projections, scenario analyses and studies that explore how overall safety performance evolves under different scenarios (Interview Bravo, personal communication, 2025). Second, interviewees emphasised that quantification has become more important when measures are costly or affect the offshore wind business case, but that models alone are insufficient. The emerging approach therefore combines modelling with expert judgement to test plausibility and address what models do not capture well (Interview Alfa; Interview Bravo, personal communication, 2025). Third, the governance debate is shifting from a broad goal (“maintain or improve safety”) to defining and defending a measurable target. This target is built on explicit discussion of residual risk and what reduction is feasible and proportionate (Interview Charlie, personal communication, 2025). Together, these elements form an evidence loop that supports earlier intervention, more defensible requirements and periodic reassessment as conditions change.

5.5.4. Bridge to synthesis

This mini-case substantiates Proposition 3 in the synthesis chapter. Incidents and OVV oversight can accelerate institutional learning by creating an accountability window in which political attention increases the mandate, resources and influence of maritime safety actors. This window supports a shift from project-by-project compliance toward a more systemic and forward-looking approach, by strengthening the evidence base needed to justify measures during offshore wind scale-up.

5.6. Conclusion

In sum, the Dutch approach stands out for its strong institutional anchoring. Maritime safety considerations are formally embedded through programme-level integration and co-signing arrangements. This created a hard governance safeguard. At the same time, the safety logic is shifting toward a Safety-II logic, emphasizing scenario-based analyses and systematic learning from near-misses instead of relying on compliance with prescriptive rules. This transition was accelerated by incidents and the OVV report, which increased political and administrative attention and pushed the system toward operational professionalisation. This is most visible through 24/7 monitoring, the deployment of Emergency Response Towing Vessels (ERTVs) and a broader expansion of maritime safety policy. Finally, the Dutch setting illustrates how polycentric governance can be experienced as a coordination burden, yet also function as a strength. The presence of multiple centres of authority creates more opportunities to build coalitions and find institutional allies when improving or safeguarding maritime safety concerns.

6

Empirical case: The United Kingdom

The United Kingdom case is included in this study because it combines a mature offshore wind sector with a governance setting that differs from the Dutch context. As a front runner in offshore wind, the United Kingdom has accumulated a lot of experience in managing interactions between wind farms and other maritime uses (commercial navigation, port access and fisheries). This maturity makes the United Kingdom an interesting case for understanding how safety integration evolves when offshore wind moves from early projects to large-scale, system-level deployment. Offshore wind is developed through separate leasing rounds led by The Crown Estate and is primarily managed through project-based permitting procedures, instead of a single integrated national spatial plan. In addition, the post-Brexit setting creates a relevant institutional condition. While international maritime standards remain central, the United Kingdom has more independence in how it translates international and European recommendations into national policy instruments.

Empirically, this chapter is built on two main sources. First, it uses United Kingdom safety guidance instruments that structure offshore wind planning and assessment in practice. This includes Marine Guidance Notes, planning policies and related standards that specify spatial constraints, risk assessment expectations and requirements. Second, it analyses two semi-structured interviews with two officials from the United Kingdom Maritime and Coastguard Agency (MCA) and one official from the Marine Management Organisation (MMO). The interviews are particularly valuable because they provide insight into how navigation safety is integrated from the earliest stages of area identification, how the Navigational Risk Assessment (NRA) is organised and quantified, how consultation is structured across actors and how design mitigation is operationalised in practice.

Chapter 6 is structured as follows. Section 6.1 reconstructs the United Kingdom offshore wind planning process, identifying the main decision points and where navigational safety considerations become locked in. Section 6.2 then describes the key navigational safety measures and governance outputs that result from this process. Section 6.3 explains why these outcomes emerge by applying the four analytical dimensions from the framework to the United Kingdom case. Section 6.4 zooms in on a mini-case to illustrate how these mechanisms play out in practice and how informal interactions translate into formal consent conditions. Finally, Section 6.5 summarises the main within-case findings and highlights the United Kingdom-specific mechanisms that will be compared to the other case in Chapter 7.

6.1. Process overview and timeline of United Kingdom offshore wind planning

The United Kingdom offshore wind planning process is structured as a staged pipeline that begins with a seabed leasing decision and progressively moves toward project-level design, assessment and consent. Key spatial steering is concentrated in The Crown Estate's (TCE) leasing rounds, choosing areas that are potentially interesting for offshore wind. Marine plans provide policy context and supporting justification, but do not tightly allocate offshore wind space, particularly for Nationally Significant Infrastructure Projects (NSIPs). It then relies on developer-led risk assessment and consultation, particularly

through the NRA, to refine designs and address navigational safety at the project stage.

6.1.1. End-to-end process

To structure the United Kingdom case analysis, this chapter distinguishes the following planning phases:

- Non-binding strategic area identification and screening (upstream steering)
- Leasing round design and award of seabed rights (commercial commitment)
- Pre-application project development (iterative design)
- Formal consenting and examination (record-based decision-making)
- Post-consent licensing, construction, operations and monitoring (implementation)

The process starts with Crown Estate seabed leasing and area identification, based on strategic screening and regulator consultation. Interviewees describe this as a multi-criteria screening exercise based on publicly available data that takes shipping, defence practice area, protected areas, environmental factors and “human factors” such as visual seascape into consideration (Interview Echo, personal communication, 2025). Interview Foxtrot adds that plan-level renewable ‘resource areas’ can be very broad, limiting their ability to allocate space precisely. Marine plan policies from the MMO provide background direction for screening and later justification, but do not function as tightly binding spatial allocation for NSIPs (see Section 6.3.2). Navigation and shipping considerations enter early through consultees, particularly the MCA, and also through bodies such as Trinity House (lighthouse authority) and the United Kingdom Hydrographic Office (UKHO). These consultees flag navigation constraints such as main routes, port approaches and routeing measures. This can lead to boundary refinements or exclusions. Document analysis similarly shows this steering role in Round 4 stakeholder feedback, where TCE narrows areas based on multi-sector constraints (including dense shipping routes and defence constraints) [58]. In other words, leasing functions as a major upstream steering point for avoiding the most problematic overlaps.

A concrete illustration is provided by TCE’s Round 5 Site Selection Methodology for the Celtic Sea [56]. TCE uses a six-step funnel that narrows a broad Key Resource Area to Project Development Areas. They describe three steps: Exclusions for hard constraints, weighting/screening of soft constraints, and refinement using technical feasibility and LCOE considerations alongside targeted stakeholder engagement. This shows that leasing is not a single decision, but a structured evidence pipeline designed to reduce consenting risk and late-stage redesign costs.

Once areas are defined for leasing and seabed rights are awarded, the process becomes developer-led. The developer initiates EIA scoping and prepares the evidence base, including navigation risk work, while regulators and sector bodies respond through consultation and requests for modification (Interview Echo, personal communication, 2025). The MCA interview clarifies that the MCA is involved early, but is not the consenting authority. Its influence is exercised through guidance, written positions and the quality of the evidence trail that enters the formal record. For offshore wind projects above 50 MW (NSIPs), the consenting decision is taken by the Secretary of State following examination led by the Planning Inspectorate. In this step, the MCA and MMO influence outcomes as statutory consultees through evidence, written representations and recommended conditions (Interview Foxtrot, personal communication, 2026). MMO’s involvement is partly driven by downstream accountability. It will regulate marine licence conditions once consent is granted (Interview Foxtrot, personal communication, 2026). For smaller offshore wind projects (below 50 MW), the MMO is the consenting authority.

After award, designs are iteratively refined in pre-application engagement and consultation before formal submission. Interview evidence describes early discussions used to test feasibility and identify major navigation issues before commitments become expensive. This enables boundary/layout changes before the project becomes procedurally fixed (Interview Echo, personal communication, 2025). Consent is then achieved through the relevant statutory route. For NSIPs, marine plan policies may inform the record but are not determinative. Departures can be justified based on the wider policy. Interview Foxtrot emphasises that licence conditions are initially drafted by the applicant. MMO therefore uses pre-application and examination stages to push for conditions that are specific and enforceable, often by consulting specialist bodies on what operational safety provisions should be included (Interview Foxtrot, personal communication, 2026). For this thesis, the key point is that the final decision sits with

the consenting institution, not the maritime safety regulator. Therefore, navigational safety influence depends on clear recommendations and defensible evidence in the consent record (Interview Echo and Foxtrot, personal communication, 2026).

Finally, construction and operations translate consent conditions into practice (e.g., temporary safety zones during construction and operational navigation arrangements). While this chapter focuses on the planning-to-consent chain, the operational phase remains relevant because residual navigational risk cannot be eliminated solely through siting and documentation.

6.1.2. Stages and lock-in points

Three lock-in points are most relevant for navigational safety. The first occurs around the transition from early area screening to tendering/bidding and commercial commitment. In the pre-tender stage, major spatial redesign is still possible. After bidding, the developer's commercial exposure increases and changes become costlier and harder to absorb (Interview Echo, personal communication, 2025). Round 5 formalised this logic by pushing more constraint resolution upstream. TCE combines hard-constraint exclusion, soft-constraint screening and additional refinement before defining specific areas for tender. This is explicitly framed as enabling earlier clarity for bidders to reduce downstream delay and risks for developers after tender closes (Interview Foxtrot, personal communication, 2025; The Crown Estate [56]).

The second lock-in point occurs once the project enters formal consenting (submission and examination). At that stage, issues are handled through the documentary record and the consenting authority's judgement. The MCA can object and recommend changes, but its influence is dependent on how clearly risks and mitigations are evidenced and argued in a form the decision-maker can rely on (Interview Echo, personal communication, 2025). Before submission, navigational issues can still be addressed through spatial redesign. After submission, they more often become disputes managed through procedural scrutiny and conditions. Interview Foxtrot similarly emphasises that at later stages, the ability to change spatial decisions is minimal, reinforcing the value of resolving conflicts early.

A third limited corrective mechanism exists post-consent. Through 'review of consents', where new evidence can trigger additional conditions, permits and plans might be re-opened (Interview Foxtrot, personal communication, 2026). For example, new evidence on construction noise, led to additional conditions on mitigating measures for noise reductions.

6.2. Safety measures in United Kingdom offshore wind

This section summarises the main navigational-safety instruments and policy outcomes produced in the United Kingdom offshore wind system, before explaining why they emerge.

6.2.1. Distances & spatial buffers

A core United Kingdom safety instrument is the use of distance baselines. During construction and certain maintenance activities, a formal 500-metre safety zone is applied around individual turbines and offshore structures [30]. This is the most clearly prescriptive separation instrument in the United Kingdom case. It creates an exclusion zone when risks are most acute and operations are most dynamic.

In operation, the baseline policy is open navigation. Interviewees describe that vessels are generally expected to keep clear of individual turbines (a 50m minimum clearance is referenced in Interview Echo and Foxtrot). This should not be read as an 'operational safety zone' in the same sense as formal safety zones applied for during construction. Developers can apply for larger operational safety zones, but interview evidence suggests this is rare (Interview Foxtrot, personal communication, 2026). The governance logic is that navigational freedom should not be restricted without a strong justification.

For siting close to traffic flows, interview evidence describes a buffer of roughly two nautical miles from major commercial routes and IMO routing measures. This functions as a baseline rather than a fixed rule. Distances may be reduced or expanded depending on local traffic characteristics and available mitigations [29]. In practice, these baselines are tested and justified through the NRA process (MGN 654), which frames acceptability in terms of intolerable risk, ALARP-tolerable risk and acceptable risk. Consenting expectations also explicitly require developers to show that the project is designed and

managed so vessels can make safe passage without significant large-scale deviations (Interview Echo, personal communication, 2025).

6.2.2. Marking and lighting

To safeguard the visibility of offshore wind farms, United Kingdom projects implement marking and lighting plans aligned with international recommendations (e.g., IALA guidance). In practice, outer turbines and key corner points are equipped with navigation lighting to outline the array boundary and support orientation. Turbine identifiers are illuminated in a more discrete manner at night. The governance point in the United Kingdom case is not the technical detail itself, but that visibility is treated as a baseline compliance outcome that is standardised through international authorities, while still leaving room to adjust implementation to context (e.g., minimising unnecessary light pollution).

6.2.3. Passage & access rules

A defining United Kingdom policy outcome is the norm of openness after construction. Operational wind farms are generally not treated as exclusion areas and safety rules are framed around maintaining clearance from individual turbines instead of prohibiting entry. Interview evidence suggests that this openness does not mean all vessels just sail through. Large commercial vessels often avoid entering the offshore wind farms due to manoeuvring constraints and uncertainty, while smaller vessels (including some fishing vessels and service craft) are more likely to navigate within wind farms (Interview Echo, personal communication, 2025). This gap between formal openness and practical behaviour is also visible with fisheries. With fisheries, insurance and liability concerns still discourage certain practices (e.g., active gear dragging) even where formal access is not prohibited (Interview Foxtrot, personal communication, 2026).

Within this open-navigation baseline, corridors and access lanes appear as a project-level instrument to provide local passage where needed. Some projects incorporate designated transit corridors (e.g., for local routes or fishing access). However, these corridors are not standardised and vary by project depending on spatial constraints and consultation outcomes (Interview Echo, personal communication, 2025). In this sense, corridors operate as a conditional instrument. They become part of a defensible solution when the NRA and stakeholder record show a need.

A further operational access outcome concerns Search and Rescue (SAR) accessibility. United Kingdom consenting expectations link navigation risk management to emergency response and to the sufficiency of radar/AIS/VHF coverage around the site [59]. Developers must show that emergency services can access and manoeuvre within arrays, but interview evidence indicates this works through parameters and targets rather than prescribed layouts (e.g., requiring at least one consistent line of orientation to support helicopter operations) (Interview Echo line 135, personal communication, 2025).

Finally, the United Kingdom open-navigation norm has an important emerging exception for floating offshore wind. Where mooring lines, anchor systems and subsea cables create hazards that are difficult to manage, access may shift toward prohibition (Interview Foxtrot, personal communication, 2026).

6.2.4. Multi-use & fishing

For multi-use and fishing, the United Kingdom baseline is again openness with negotiated mitigation. EIAs need to assess restriction of access and disruption of fishing activity during construction and operation. Interview evidence suggests fisheries coexistence is operationalised through a mix of guidance, consultation and enforceable project commitments (Interview Foxtrot, personal communication, 2026). Developers may be required to produce a fisheries liaison/coexistence plan developed with fishing representatives, using coordination forums such as FLOWW (Interview Foxtrot, personal communication, 2026). The governance idea is to manage impacts without establishing a single “multi-use permit regime”. At the same time, interview evidence highlights unresolved responsibility questions (e.g., liability and safe removal when static gear fouls monopiles), showing that open access does not resolve all issues (Interview Foxtrot, personal communication, 2026).

6.2.5. Monitoring & emergency response measures

Monitoring

Monitoring around offshore wind farms relies primarily on AIS visibility, which is mandatory for vessels above specified sizes. However, the United Kingdom case material notes that the United Kingdom does not operate a dedicated offshore surveillance system that monitors wind farm areas as a national priority [30]. Instead, monitoring capacity is frequently project-assigned. Developers typically install radar, AIS receivers, VHF communications equipment and sometimes CCTV within or near wind farm boundaries. These systems are primarily to support operational safety and maintenance coordination, but HM Coastguard can access them upon request. VTS coverage remains concentrated around major ports and coastal approaches rather than offshore wind zones.

Emergency response capacity

The United Kingdom previously maintained a larger network of state-funded Emergency Towing Vessels (ERTVs), but following review and cost-benefit assessment, three ERTVs were withdrawn. A single vessel remains stationed in northern Scotland where distances to harbour tugs and heavy weather conditions justify continued coverage [37]. Materials suggest this policy is partly justified by the availability of nearby commercial vessels and private capacity to assist in many areas [55]. Interviewees nevertheless flag implications for preparedness in increasingly congested offshore wind regions where a drifting vessel can escalate quickly (Interview Echo and Foxtrot, personal communication, 2025-2026).

HM Coastguard's Search and Rescue fleet also consists of reactive response for incidents at sea. They operate approximately 20 helicopters distributed across the United Kingdom coastline and operating under continuous readiness [18]. The United Kingdom shows that this SAR service coordinates closely with wind farm developers, including for medical evacuations, personnel transfer incidents or emergencies within turbine areas, making SAR a core part of the reactive safety system around offshore wind.

6.3. Explaining United Kingdom outcomes using the analytical framework

This section explains why the United Kingdom produces the safety-governance outcomes described earlier by applying the four analytical dimensions of the framework from chapter 3. The aim is not to describe the process again, but to show how specific institutional mechanisms (e.g., how international standards are translated, who can “block” or “steer” projects and how soft guidance becomes enforceable) shape United Kingdom planning and safety integration in offshore wind.

6.3.1. Vertical coordination across governance levels

United Kingdom safety influence is strong but indirect. Binding international constraints set non-negotiables, while national guidance and the consent record decide maritime regulator influence through leasing screening, NRA evidence requirements and enforceable conditions.

Translation of international guidance into national regulation

Vertical coordination in United Kingdom navigational safety starts with hard international constraints and is operationalised through national guidance + project-level evidence. IMO instruments (SOLAS Chapter V and IMO-adopted routeing measures) create non-negotiables. Fixed infrastructure cannot obstruct adopted routeing structures. In practice, the United Kingdom translates this vertical chain into project governance through MCA guidance and NRA expectations, which specify how developers must evidence safe passage and acceptable residual risk (Interview Echo, personal communication, 2025).

A substantial share of regulation therefore occurs through non-binding standards becoming binding in practice once they are put in guidance and embedded in the consenting record. A central example is IALA guidance for marking and lighting (IALA G-1162), which becomes a concrete design and compliance expectations through MGN 654 [31]. Interview evidence also points to distance and layout approaches originating from professional communities (e.g., PIANC, Nautical Institute) as “sound judgement and good data” that are relatively straightforward to incorporate into guidance (Interview Echo, personal communication, 2025).

International coordination is treated not only as a legal constraint but also as a capacity and competitive-

ness mechanism. Interview Foxtrot argues that resource-heavy international procedures can become unworkable at the scale of offshore renewables (e.g., if such procedures were required for thousands of decommissioning decisions). At the same time, standardisation is valued because it reduces differences across neighbouring states. More restrictive national interpretations can translate into higher project costs and competitive disadvantage (Interview Foxtrot, personal communication, 2026).

This layered translation also highlights what is not vertically embedded. The DNV white paper *Offshore renewable risk management: A pragmatic safety case* argues that United Kingdom offshore renewables is governed through general health-and-safety duties (Management of Health and Safety at Work Regulations, Construction (Design and Management) Regulations), but that these do not clearly drive identification and management of major-accident hazards for offshore renewables [11]. It further notes that the United Kingdom's offshore safety case regime for oil and gas does not extend to wind farm structures. This creates a boundary where navigational safety is highly operationalised through MCA guidance, while major-accident governance is not embedded in renewables in the same formal way [11].

Overall, the United Kingdom case produces a different form of vertical translation. Binding IMO/SOLAS obligations define non-negotiables (e.g., fixed infrastructure must not obstruct IMO-adopted routing measures), while MCA guidance operationalises how navigational risk is assessed and what mitigation is expected. This layered structure also exposes a boundary in the wider renewables safety regime. The DNV white paper argues there is still no clear requirement in offshore renewables to identify and understand major-accident potential, manage the associated risk or demonstrate how that risk is managed [11].

Vertical coordination and responsibility allocation

In the United Kingdom case, vertical coordination is visible in a relatively clear allocation of roles across governance levels, with influence exercised through distinct levers (space, evidence, consent conditions, and operational requirements):

- **Upstream spatial steering (seabed access):** The Crown Estate has a powerful upstream position through leasing rounds and area selection. It can exclude zones where cumulative or strategic constraints seem too high, while leaving “manageable with mitigation” issues to project-level assessment.
- **Marine plan policy baseline:** MMO's marine plans provide policy direction and evidence used in screening and justification. However, interview emphasises that these plans are often broad and decision-makers may justify other choices. This limits their force as a binding allocation instrument (Interview Foxtrot, personal communication, 2026).
- **Operationalisation of navigational safety:** The MCA translates international rules and standards into United Kingdom guidance and assessment expectations (notably MGN 654), shaping NRA scope, evidence, and consultation [31].
- **Consent decision (NSIPs):** Planning Inspectorate (examining authority) and the Secretary of State (final decision).
- **Implementation:** Developers demonstrate safety and implement mitigations (layout, corridors, marking/lighting, monitoring, emergency access provisions) through NRA documentation and compliance with consent expectations.
- **Enforceable licence conditions:** MMO reviews marine licence conditions through a “specific and enforceable” lens. They consult specialist bodies on what operational requirements are needed. They later regulate compliance and license decommissioning (Interview Foxtrot, personal communication, 2026).
- **Who signals expectations beyond navigation (major-accident response):** Dimelow [11] identifies HSE-MCA Offshore Information Sheet 02/2019 as a only indicator of regulator expectations for renewables, operating primarily through guidance rather than binding law.

Interview Foxtrot highlights a structural coordination gap. Despite multiple planning and regulatory bodies, there is no single actor responsible for one marine spatial plan and offshore wind system,

which contributes to inconsistent integration across domains (Interview Foxtrot, personal communication, 2025)

Two authority mechanisms stand out. First, the MCA's influence operates largely through recommendation power. It is not the consenting authority, but it can recommend objection or non-approval where navigation risks are not sufficiently mitigated. Second, it holds a zone of uncertainty around risk acceptability and evidence reliability (e.g., what counts as ALARP; which modelling assumptions are credible). This strengthens their steering position without a formal veto. Interview evidence suggests decision-makers rely heavily on MCA safety advice in justifying outcomes. Override is possible in principle, but institutionally unlikely unless the safety basis is addressed (Interview Echo, personal communication, 2025). MMO's influence is similarly shaped by downstream accountability (it regulates conditions post-consent), but it cannot always ensure preferred conditions translate into the NSIP decision (Interview Foxtrot, personal communication, 2026).

Regulatory stability vs change

Post-Brexit, interviewees state continuity in navigational safety standards for offshore renewables, because of continued IMO membership and reliance on international standards-setting arenas (including IALA work) (Interview Echo, personal communication, 2025). They also emphasise that EU-level shifts are unlikely to drive major change in this domain because the most influential standards are international (IMO/IALA) and North Sea–regional professional coordination rather than EU directives (Interview Echo, personal communication, 2025).

At the same time, the United Kingdom shows ongoing adaptation through national guidance design and assessment practice. Interviewees describe a sequence of MCA guidance updates in MGN 654, framed as revisions “according to experience” (Interview Echo, personal communication, 2025; Maritime and Coastguard Agency [31]). An example is the update of the guidance when turbines became too big for SAR helicopters to fly over. This resulted in a revision, stating that access lanes for helicopters had to be implemented. Interview Foxtrot characterises marine planning and assessment as continuously revised (“nothing is fixed”). This included updates of evidence bases (e.g., fisheries inputs), monitoring approaches and impact assessment expectations as new industries and information emerge (Interview Foxtrot, personal communication, 2026). Dimelow [11] adds a stabilising mechanism. Unlike oil and gas, offshore renewables has not (yet) had an industry-defining accident that triggers a major regulatory redesign, so regulation remains dominated by non-industry-specific frameworks despite rapid technological scale-up [11].

6.3.2. Horizontal coordination and balance of interests between sectors

Coordination is organised around structured consultation and NRA/EIA + the consent record across multiple arenas. Therefore, trade-offs are usually settled through early redesign before lock-in, with unresolved conflicts channelled into examination and conditions rather than resolved by a single spatial planning authority.

Horizontal coordination in the United Kingdom case is characterised by multi-actor negotiation within a formally structured process, where sectoral interests are brought together at different stages (leasing, consultation, licensing, and sector forums). Interview Foxtrot describes this as sometimes ‘messy’ spatial planning. Marine planning, energy-system planning and leasing pursue different objectives without a single actor responsible for marine spatial planning of the whole system (Interview Foxtrot, personal communication, 2026). Interview Foxtrot also expects increasing fragmentation as additional programmes introduce their own optimisation logics. In particular, the electricity system operator (NESO) is developing a Strategic Spatial Energy Plan (SSEP) that prioritises production locations based on system needs. This will create another upstream constraint expected to influence future Crown Estate leasing rounds (Interview Foxtrot, personal communication, 2026).

Coordination also occurs in a risk context where operational experience and incidents in offshore wind are increasing, particularly on vessels supporting construction and operations [11]. This means the coordination challenge is not only spatial coexistence, but also preventing high-consequence events emerging from routine multi-actor offshore operations.

Actors, timing and influence

Influence is stage-dependent: Upstream actors steer where development is possible, while statutory consultees can influence how risks are evidenced and mitigated. Consenting institutions decide when agreement is incomplete.

During strategic area identification, TCE acts as upstream organiser and spatial gatekeeper. They screen areas using a mix of spatial evidence (including marine plan baselines) and consultee input (e.g. MCA). Round 5's site selection process explicitly draws on marine planning authorities and marine-plan related inputs as part of its evidence base. This reinforces that marine planning influences upstream screening even if it is not determinative in NSIP outcomes (Interview Foxtrot, personal communication, 2026; The Crown Estate [56]). It looks for candidate areas and iteratively narrows boundaries through multi-criteria analysis. Navigational safety influence in this phase is exercised primarily through the MCA (where relevant, Trinity House and the United Kingdom Hydrographic Office) by flagging high-risks such as main traffic routes, IMO routeing measures and port approaches. This sometimes results in boundary refinements or exclusions before projects become locked in (Interview Echo, personal communication, 2025). Interview Foxtrot states ongoing efforts to link MMO and Crown Estate data platforms to better align upstream evidence bases (Interview Foxtrot, personal communication, 2026).

In NSIP decision-making, marine plans are not the only reference point. Interview Foxtrot emphasises that the Secretary of State can justify outcomes by relying on national policy statements that set sector priorities. The Thanet Extension case is offered as an illustration. An offshore wind proposal in a congested Thames context was refused due to conflict with the National Policy Statement for Ports. This shows how cross-sector policy can be decisive even when renewable targets are very important (Interview Foxtrot, personal communication, 2026; House of Commons Transport Committee [21]).

As projects move into developer-led assessment and design, the actor set expands and coordination becomes structured around consultation. Developers consult the MCA, General Lighthouse Authorities, shipping representatives, fishing representatives, recreational users and ports and harbours (Interview Echo, personal communication, 2025). Depending on location, additional actors can become decisive (e.g., Ministry of Defence where defence areas are affected, environmental bodies where protected areas are affected). Interviewees also report a prioritisation shift. They argue that “only in the last 5 years” navigation has been given the highest weighting in offshore wind planning, whereas “three, five years ago” it was viewed as less important by other government departments (even if not by the MCA itself) (Interview Echo, personal communication, 2025). This aligns with the DNV observation that incident experience is increasing in offshore wind operations [11]. They state that the Piper Alpha in the oil industry led to tighter safety management in the industry. The offshore wind energy sector in the United Kingdom did not have an industry changing accident like the Piper Alpha in 1988. The interviewees further claim that today navigation and shipping are weighted at the same level as protected areas, implying a shift in how shipping safety competes with environmental designations. A practical implication is the emphasis on early engagement with current operators, developers and vessel crews. They stress that experiential knowledge can quickly become outdated as vessel patterns, operators and services change. “The earlier the better” reduces late objections once proposals are finalising (Interview Echo, personal communication, 2025).

Finally, Interview Foxtrot highlights that attempts to make marine planning “more spatial” can generate resistance. Especially in fishing, fishing grounds are perceived as mobile. They can not tell if a offshore wind area will impede their fishing area, because they change locations year-round. At the same time, credibility challenges in objections have increased efforts to map important fishing areas to strengthen earlier-stage evidence and reduce downstream conflict (Interview Foxtrot, personal communication, 2026).

Coordination mechanisms: formal arenas, structured consultation, and informal early engagement

United Kingdom coordination runs through recurring arenas that translate stakeholder interests into traceable evidence and (where needed) enforceable conditions. Horizontal coordination occurs through six main mechanisms.

- **Leasing working groups:** First, during leasing and area identification, interviewees describe

Crown Estate programme working groups that bring together relevant parties to discuss constraints and adjust areas before tendering (including shipping constraints raised by the MCA). The format is not fully institutionalised and is reconfigured each round (Interview Echo, personal communication, 2025).

- **Marine plans as a shared baseline:** Second, the statutory marine planning layer as a shared reference frame. Beyond project-specific coordination, Interview Foxtrot emphasises that England’s marine plans provide a (spatial) policy baseline that shapes how actors frame constraints and “least impact” arguments. This includes upstream screening by The Crown Estate (Interview Foxtrot, personal communication, 2026). However, these plans do not operate as a tightly binding zoning instrument for offshore wind siting, particularly for NSIPs. Here decision-makers may justify departures from plan policies. In practice, marine plans therefore support horizontal coordination by aligning expectations and data across organisations, while substantial discretion remains in leasing and NSIP decision-making.
- **NRA/EIA as boundary objects:** Third, at the project level, the NRA and EIA function as the most structured coordination arenas. They integrate and shape consultation, stabilise positions into documents and create a shared evidence base around shipping risks. Interviewees state that the United Kingdom risk assessment methodology follows the IMO methodology and that a “key part” of this process is consultation. Developers consult the MCA, the General Lighthouse Authorities, as well as local shipping, fishing and recreational representatives and ports and harbours. Consultants produce risk analyses, stakeholders respond with concerns and requests and negotiated design modifications are incorporated into revised plans.
- **MMO as a coordination node for enforceability:** Fourth, interview Foxtrot emphasises MMO’s role in coordinating across actors to translate sector requirements into marine licence conditions that are specific and enforceable, even when the NSIP consent decision sits elsewhere (Interview Foxtrot, personal communication, 2026).
- **Informal early “pre-meetings”:** Fifth, interviewees distinguish a softer, informal layer of coordination through early “pre-meetings” with developers. These discussions often happen before big commercial commitment. They can involve several developers in parallel and are used to identify feasibility issues early, reducing the risk that navigation objections emerge only after proposals become formalised (Interview Echo, personal communication, 2025).
- **Sector-wide safety knowledge production:** Sixth, cross-organisational initiatives (G+ and “safe by design” workshops, RenewableUnited Kingdom guidance) contribute learning and methods, but the DNV paper notes much of this focuses on occupational health and safety rather than full major-accident hazard management [11].

In addition, fisheries-wind coordination is supported by the Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW). The Crown Estate describes FLOWW as established in 2002 to support relations and coexistence between fisheries and offshore renewables. They do this by accommodating discussion of interaction issues and best-practice guidance [57]. Interview evidence identifies FLOWW as a key arena where fishing-wind interactions and best practice (and, in practice, compensation discussions) are addressed. Interview Foxtrot links this forum to enforceable practice via licence expectations. Developers need to include requirements for a fisheries coexistence/liaison plan submitted to MMO for approval before construction (Interview Foxtrot, personal communication, 2026).

Together, these mechanisms imply that United Kingdom coordination is neither purely formal nor purely informal. Early informal engagement enables redesign before lock-in. Formal NRA consultation give legitimacy and traceable documentation as projects enter consenting. Sector-specific forums like FLOWW provide an additional coordination channel where multi-use tensions (in this case fisheries) are discussed beyond individual projects.

Trade-offs and agreements: how multi-use is turned into spatial solutions

Trade-offs in the United Kingdom case are typically resolved through spatial and design mitigation that enables coexistence. Interviewees repeatedly describe boundary reduction as the most common mitigation (“the favourite one”). They characterise navigation mitigation as primarily “avoid or minimise” rather than compensate (Interview Echo, personal communication, 2025). Corridor-making is a second

recurring instrument, with lanes or routes through wind farms to maintain access to ports, separate flows or preserve routes for fishing vessels to reach grounds. Interview Foxtrot gives examples of redesign outcomes, including North Falls (portion removed to accommodate shipping) and Westernmost Rough (layout adjustments, including gaps, to support fisheries access) (Interview Foxtrot, personal communication, 2026). SAR and emergency response concerns are also translated into layout requirements negotiated within constraints rather than prescribed as full designs; interview evidence notes that at least one SAR-oriented lane/line of orientation is expected to support helicopter operations (Interview Echo, personal communication, 2025).

The DNV paper suggests a limitation of relying mainly on negotiated spatial solutions. Although guidance exists and continues to develop, it focuses largely on occupational risk rather than systematic identification and management of major-accident hazards. They emphasise “avoid/minimise” bargaining may not yield a complete demonstration of control of high-consequence risks [11].

Coordination is also not frictionless. Contestation is most visible around fisheries, where coexistence expectations clash with perceived loss of space and compensation debates. Interviewees state that although best-practice guidance exists, key fishing federations (particularly Scottish fishers) withdrew from the process. This indicates that coordination arenas can fail to stabilise agreement when representation and perceived fairness remain contested (Interview Echo, personal communication, 2025). Interview Foxtrot additionally highlights unresolved accountability questions despite openness (e.g., responsibility and liability when static gear damages monopiles), suggesting that negotiated coexistence does not automatically resolve operational gaps (Interview Foxtrot, personal communication, 2026).

When conflicts keep existing within project processes, the United Kingdom system channels disputes into the consenting pathway. Engagement may still lead to partial agreement, but unresolved issues can carry into application and examination where documented evidence and recommendations are weighed by the consenting authority (Interview Echo, personal communication, 2025). This shows the United Kingdom model relies on a combination of negotiated settlement if possible, and judgement where agreement cannot be reached. The NRA consultation record function as a solution between stakeholder contestation and formal decision-making.

These negotiated spatial solutions illustrate how horizontal coordination happens in practice:

- Shipping safety is operationalised through buffers, lanes and avoidance of routing measures and port approaches.
- Fishing access is remained through route protection to fishing grounds and design choices (e.g., wider spacing between turbines, grid formats) that allow continued fishing in or around fixed-bottom sites.
- SAR and emergency response concerns are translated into turbine layout, negotiated within constraints rather than prescribed as full designs. At least one SAR lane must be implemented, in a preferred direction, for SAR helicopters to search the area (Interview Echo, personal communication, 2025).

6.3.3. Timing and mode of safety integration (Safety-I vs Safety-II)

This section analyses when navigational safety enters the United Kingdom offshore wind planning process and how safety is conceptualised and managed. Using the Safety-I/Safety-II lens, the evidence suggests a predominantly Safety-I framing (risk identification, probability/consequence thinking, mitigation). This is complemented by Safety-II elements through iterative learning, early engagement and adaptive guidance updates and (via MMO) the translation of concerns into enforceable marine licence conditions and periodic plan reviews.

The DNV paper (2025) complements this Safety-I/Safety-II reading by calling offshore renewables a “major accident” industry with hazards largely comparable to offshore oil and gas. At the same time, they highlight that offshore renewables has no mandated requirement for formal risk management or a safety case [11]. This combination can reinforce a predominantly Safety-I orientation at project level, while leaving proactive learning and integration largely voluntary practice.

When safety enters: early involvement and pre-tender redesign

Safety influence is greatest when it enters before commercial and procedural lock-in, so early engagement and upstream screening are used to prevent late-stage conflict.

Interviewees mention that the MCA is involved “right from the very start,” including area identification linked to seabed leasing and later developer-led EIA and NRA (Interview Echo, personal communication, 2025). This early integration is reinforced by informal pre-meetings with developers before designs become locked in and costly to change. Interview Foxtrot clarifies that MMO’s involvement begins at the pre-application stage after lease award, when developers share draft proposals and receive consultee feedback. However, Foxtrot also notes that MMO works closely with TCE during upstream screening by providing policy and spatial evidence through marine plans and associated datasets. To strengthen their involvement, they are in the process of trying to link MMO and Crown Estate data platforms to align evidence bases earlier in the process (Interview Foxtrot, personal communication, 2026). This indicates emerging earlier-stage coordination even if leasing decisions remain primarily Crown Estate-led.

Early involvement also aligns with Dimelow [11]’s warning that offshore renewables has not yet had an industry-defining major accident, even as incidents are increasing. It argues that more structured approaches should be adopted proactively rather than only after a catastrophic trigger [11].

The Crown Estate [56] indicates a deliberate shift toward earlier system learning at the leasing stage. TCE integrates spatial design with plan-level assessments ahead of tenders and uses an iterative process to develop less constrained Project Development Areas (PDAs). This functions as a Safety-II style move. Stabilising shared evidence earlier to reduce downstream rework and consenting risk, while leaving project-level NRAs to handle remaining site-specific residual risks

Scope of assessment: strategic screening versus project-level NRA

The United Kingdom case shows two distinct assessment scopes. At the strategic level (leasing), interviewees describe using AIS data to identify main routes and support a pragmatic red/amber/green logic. Red areas should not be developed, amber may be possible with mitigation, and green areas are more suitable (typically more offshore and away from busy routes) (Interview Echo, personal communication, 2025). This is not a comprehensive navigational risk assessment for the United Kingdom EEZ, but a screening approach to identify obvious conflicts early.

At the project level, the core analytical instrument is the Navigational Risk Assessment (NRA). Interviewees indicate that consultants often include cumulative considerations within a defined radius (e.g., “15 miles” for project-area considerations), but this remains anchored in project boundaries rather than a whole-system hazard register (Interview Echo, personal communication, 2025).

The DNV paper points to the implications of this scope choice. Project-level processes like NRAs can structure navigational collision risk. However, offshore renewables lack an explicit requirement to identify and demonstrate control of major-accident hazards through a comprehensive risk management demonstration [11]. Interview Foxtrot also suggests capacity constraints on knowledge production. Several proposed projects on cumulative impacts for shipping/navigation did not proceed within their evidence register, limiting expansion beyond project-level assessments (Interview Foxtrot, personal communication, 2026).

Safety-I emphasis on collision risk, baseline vs “with project” scenarios, and mitigation

The safety framing is strongly Safety-I. Interviewees describe quantifying collision likelihood by comparing baseline risk (“as it is now,” including incident history) with a worst-case placement scenario of a wind farm in that location. This is followed by mitigation analysis focused on layout and boundary options (Interview Echo, personal communication, 2025). Mitigation is framed in classic risk-management terms (avoid/minimise), where boundary reduction or boundary shifts are described as the most consequential and “favourite” mitigation, complemented later by operational mitigations (e.g., vessel guidance or traffic monitoring) (Interview Echo, personal communication, 2025). This structure aligns with a Safety-I logic: identify hazards, estimate risk and reduce risk through targeted interventions.

Dimelow [11] reinforces why this Safety-I focus concentrates on collision and operational interfaces. It argues that many major accident hazards in offshore oil and gas also apply to offshore renewables (including ship collision and loss of stability). This makes vessel/structure interactions and construction/operations a natural focus for probability-consequence analysis [11]. Interview Foxtrot reinforces that United Kingdom mitigation often aims to preserve openness to navigation in operational phase, relying on design and conditions rather than permanent exclusion. Formal safety zones beyond temporary phases are not commonly used, so mitigation is embedded primarily in layout choices and consent/licence conditions (Interview Foxtrot, personal communication, 2026).

Uncertainty handling: limited forecasting and reliance on growth assumptions

Uncertainty is acknowledged, especially regarding future traffic patterns and port/harbour route changes. Interviewees describe this as difficult to predict and that long-term scenario modelling does not seem central. Where future conditions are considered, this tends to occur through consultant growth assumptions (e.g., assumed traffic increases) that are explicitly described as unpredictable in sectors such as fishing and oil (Interview Echo and Foxtrot, personal communication, 2025–2026). Interview Foxtrot also highlights institutional uncertainty created by parallel programmes (leasing, marine planning, and energy system planning), which can introduce new constraints over time and make long-term spatial expectations less stable (Interview Foxtrot, personal communication, 2026). This suggests a practical, bounded approach to uncertainty. Rather than attempting full system forecasting, the process uses extrapolations and sensitivity assumptions within the NRA.

Learning orientation: Safety-II elements through early engagement and adaptive guidance

Although the analytical logic is primarily Safety-I, the United Kingdom case exhibits Safety-II characteristics in how it learns and adapts over time. The DNV paper calls learning from experiences important because it argues that offshore renewables is already experiencing accident types similar to those seen in oil and gas [11]. This implies that safety lessons are not automatically transferred between industries and that proactive learning mechanisms are needed to prevent repeating mistakes. Interviewees explicitly say that “early consultation is key” and provide examples where late consultation results in late objections and friction. This suggests that learning is embedded in the process, bringing key actors with up-to-date knowledge in earlier to prevent downstream problems, but that more learning mechanisms could be build in.

A further Safety-II mechanism is upstream learning at the leasing stage. TCEs Round 5 and interview Foxtrot show leasing becoming more research- and evidence-intensive, aiming to reduce downstream consenting risk and costly late redesign. If lease areas are poorly characterised, developers may invest heavily only to face refusal later. Round 5 therefore front-loads spatial evidence gathering, hard-constraint exclusions, screening and iterative stakeholder engagement [56]. This represents institutional learning across rounds. They increase up-front examination to reduce the probability of “high-cost failure” later.

A second Safety-II mechanism is adaptive rule-making through guidance updates. Interview Echo describes revisions of MCA guidance (MGN updates) driven by experience and changing operational realities, including evolving layout expectations as turbine scale-up increased SAR access requirements (Interview Echo, personal communication, 2025). Interview Foxtrot also notes corrective options after consent, through review of consents leading to additional conditions). This illustrates that learning can be institutionalised later but at higher transaction cost than early redesign (Interview Foxtrot, personal communication, 2026). Next to navigational guidance, Interview Foxtrot describes broader review across offshore wind governance (monitoring, impact assessment practice, and modelling), captured by the statement: “Every single part of the entire system is up for review. Nothing is fixed.” (Interview Foxtrot, personal communication, 2026). For example conflicts over assessment adequacy, with fisheries arguing EIAs assess the wrong things, created pressure for reform. This shows learning driven by stakeholder experience (Interview Foxtrot, personal communication, 2026).

This indicates a combination of the two safety perspectives. The United Kingdom manages navigational safety predominantly through Safety-I risk assessment and mitigation, while incorporating Safety-II principles via adaptive rule-making, learning from operational experience and front-loading stakeholder engagement to keep the system workable as offshore wind scales. While the empirical material does not

indicate a shift toward either paradigm, the white paper shows what a move toward stronger proactive assurance could look like. A risk management approach specifically for offshore renewables that integrates hazard identification, risk assessment and barrier management into a single risk management demonstration document.

6.3.4. Dual-layer compliance structure

The United Kingdom case is characterised by a dual-layer compliance structure in which navigational safety is governed through a prescriptive baseline of hard constraints that projects can not violate and minimum requirements they must meet. It is complemented by a performance-based oversight layer that relies on quantified risk assessment, consultation, and iterative redesign. For NSIPs, this performance layer is translated into the consent record and, where relevant, into marine licence conditions that are specific and enforceable. This layered structure combines minimum demands with flexibility in how developers achieve safe outcomes in specific locations.

This dual-layer logic is visible not only at project level (through the NRA) but also upstream in leasing design. TCE's Round 5 methodology combines a hard-constraint "Exclusions Model" (areas removed from development) with a weighted "Restrictions Model" for soft constraints [56]. In other words, "prescriptive baseline + performance-style trade-off" appears twice. First in lease-area definition and again in project-level NRA and consenting.

Prescriptive baseline: non-negotiable constraints and minimum requirements

The first layer consists of rules and standards that function as baseline constraints during early planning and project assessment. Interviewees give three core siting principles used: First, do not build infrastructure on an IMO routing measure or within a two-nautical mile buffer. Second, avoid placing major structures in major navigation routes. Third, do not impede access to harbours (Interview Echo, personal communication, 2025). Interview Foxtrot similarly describes the first rule as non-interference with IMO-established routing measures combined with a standard distance expectation, while noting that deviations can be justified in specific cases (Interview Foxtrot, personal communication, 2026).

In addition, the prescriptive layer includes minimum technical and operational requirements. United Kingdom guidance specifies baseline expectations for turbine spacing and navigability (e.g., 500 metres spacing, increasing with rotor size) [28]. It also includes prescriptive requirements for marking/lighting and the application of safety zones during construction and other temporary phases [29]. A further baseline expectation is that wind farms should not unnecessarily restrict navigation once temporary restrictions lapse, aligning with the broader United Kingdom open-navigation norm (Interview Echo, personal communication, 2025).

Together, these elements form a minimum compliance layer. They specify what cannot be impeded (IMO routing measures, key routes, port approaches) and the minimum technical conditions (spacing, marking/lighting, temporary safety-zone practices) that must be satisfied before residual-risk questions are considered.

Performance-based oversight: demonstrating acceptable risk through NRA evidence and iterative redesign

The second layer is performance-oriented and is implemented primarily through the Navigational Risk Assessment (NRA), consultation and evidence review. Interviewees describe comparing baseline collision risk ("as it is now," including incident history) with a "with project" scenario, followed by testing mitigation options and redesign where needed (Interview Echo, personal communication, 2025). For NSIPs, this evidence is weighed by the decision-maker alongside broader policy considerations.

Within this layer, oversight operates through parameters and targets rather than fixed designs. For example, SAR accessibility is treated as a requirement, but the MCA does not design the layout. Instead it sets parameters such as requiring at least one consistent line of orientation to support helicopter operations. They leave it to developers to meet the requirement through their own design solutions (Interview Echo, personal communication, 2025). More generally, mitigation is achieved through iterative negotiation and redesign. Boundary reductions, corridor creation and layout modifications are discussed with stakeholders, incorporated into revised plans, and then assessed quantitatively by consultants.

The siting-distance framework illustrates how the performance layer complements the baseline. Interviewees explain that while a two-nautical-mile stand-off from IMO routeing measures is a standard expectation, cases closer than this are assessed using a distance-risk framework that categorises outcomes as intolerable, tolerable if ALARP or broadly acceptable [29]. This shifts decision-making from a single distance threshold to an evidence-based judgement. If the project increases collision risk, developers are expected to redesign (e.g., boundary reduction, corridors) and justify remaining residual risk through quantitative assessment and consultation [29].

A crucial feature of this layer is that oversight needs to be supported by traceable documentation and recommendations. MCA recommendations must be made “very, very clear” and be supported by evidence so that decision-makers can rely on them. In this way, the performance layer not only manages risk through iterative redesign, but also constructs the documentary basis that enables consenting authorities to accept, condition or reject projects.

Who pays and who implements: developer responsibility, viability and compensation

Across both layers, the United Kingdom case places primary responsibility for implementation on the developer. Interviewees state that the developer is responsible for mitigation measures, including design adjustments and other mitigating measures during operation. The developer evaluates whether a project remains economically viable after required changes (Interview Echo, personal communication, 2025). Developers also provide the data for assessment (including up-to-date information for traffic pattern analysis) and are required to undertake consultation with the relevant stakeholder set.

For fisheries, interview Echo suggests coexistence and compensation are addressed largely through sector coordination arenas and best-practice processes (e.g., FLOWW), rather than a binding multi-use regulations (Interview Echo, personal communication, 2025). At the same time, Interview Foxtrot emphasises that negotiated outcomes can be translated into enforceable commitments. Developers may be required via marine licence conditions to prepare a fisheries coexistence/liaison plan in consultation with fishing representatives and submit a signed version to MMO for approval prior (Interview Foxtrot, personal communication, 2026). In this sense, FLOWW shapes expectations while the marine licence provides enforcement. However, Interview Foxtrot highlights unresolved responsibility and liability questions (e.g., static gear fouling monopiles and who safely removes it), indicating that negotiated coexistence does not automatically resolve day-to-day accountability issues (Interview Echo; Interview Foxtrot, personal communication, 2025-2026).

6.4. Mini-case: North Falls (Thames)

This mini-case was selected because it captures a lock-in moment in the United Kingdom process and shows how informal safety concerns are translated into formal requirements through the NRA, scoping expectations and the consenting record. It provides a concrete illustration of the United Kingdom’s typical mitigation pathway: *avoid/minimise* navigational risk through early spatial redesign and stabilise the outcome through traceable evidence and enforceable conditions.

6.4.1. Trigger: corridor constraints become decision-relevant

North Falls is located in the Thames Estuary, in a dense routeing area connected to London approaches. Scoping material and interview evidence indicate that the project area sits close to internationally recognised routeing structures (including a Traffic Separation Scheme and precautionary area). It also interacts with a recommended ferry route The Planning Inspectorate [59]. The trigger in this case was that the initial project boundary was seen as limiting the available room near these routeing structures, creating concerns about safe passage in a corridor already characterised by high through-traffic (Interviewee Echo, personal communication, 2025; The Planning Inspectorate [59]). Interview Foxtrot (MMO) independently references North Falls as a case where part of the proposed site was removed to keep space for shipping, reinforcing that navigation constraints can reshape project boundaries at an early design stage (Interview Foxtrot, personal communication, 2026).

6.4.2. Mechanism illustrated: early redesign + record-proof evidence stabilised the trade-off

The issue was addressed while design flexibility still existed. Interview Echo describes how the boundary was moved back by approximately one nautical mile and how a commitment was made not to install surface structures within one mile of the relevant edge (Interview Echo, personal communication, 2025). The same account illustrates the underlying trade-off logic. Where routing measures and high-density traffic patterns are impacted, building too close becomes difficult to defend in the evidence record. At the same time, interviewees emphasise that maintaining a corridor wide enough to be safe (described as several miles) can quickly become economically infeasible, creating a feasibility constraint on how far risk can be reduced through spatial redesign alone (Interview Echo, personal communication, 2025).

In the United Kingdom consenting system, this type of negotiated outcome is stabilised through evidence and procedure. The Planning Inspectorate's scoping opinion requires a Navigation Risk Assessment aligned with the MCA and Trinity House, including consideration of cumulative effects [59]. Interview Foxtrot adds that MMO closely monitors how such requirements are translated into specific and enforceable conditions for marine licensing and post-consent compliance (Interview Foxtrot, personal communication, 2026). This shows how safety influence operates through documented recommendations and an evidence trail an inspector can rely on (Interview Echo, personal communication, 2025).

This mini-case shows the United Kingdom within-case mechanism that navigational safety should be integrated primarily through early spatial redesign and record-proof risk demonstration. It shows how consultation and evidence requirements can translate corridor constraints into binding commitments (boundary shift and setback) that can be defended in examination. These United Kingdom-specific mechanisms are carried forward into Chapter 7 for cross-case synthesis.

6.5. Conclusions

Overall, the United Kingdom case can be seen as a polycentric and partly fragmented national planning. Statutory marine planning sits with the MMO, system-level coordination is increasingly shaped by NESO (energy supply coordination/strategic planning) and seabed leasing is driven by The Crown Estate. Crucially, The Crown Estate explicitly states it is not the statutory marine planning authority, but its leasing rounds still function as a powerful spatial filter for what gets developed. In response to issues of permits, governance has been pushing for more steering upstream with better "buildability" considerations to reduce costly late-stage redesign, delays or denials once developers have already invested significant amounts of money. This urgency was seen in 2025, when reporting highlighted how inflation and supply-chain/port/vessel bottlenecks were threatening delivery timelines and targets [60].

7

Synthesis: Comparative analysis of Governance and safety paradigms

This chapter synthesises the empirical findings from the two case chapters and develops a structured case comparison between the Netherlands and the United Kingdom. The comparison is structured dimension-by-dimension along the analytical framework. Each dimension is discussed using the same logic to maximise transparency and comparability:

1. Within-case synthesis (NL): summary of the key findings for that dimension, using the operational indicators as organising points.
2. Within-case synthesis (UK): equivalent summary for the United Kingdom.
3. Cross-case comparison: similarities, differences and a short mechanism statement that explains why the observed difference occurs (e.g., differences in institutional roles, decision rights, evidence requirements or sequencing of decisions).

The chapter concludes by showing patterns that connect the four dimensions (e.g., recurring “design logics” such as plan-led gatekeeping versus developer-led proof). These patterns provide a bridge to Chapter 8, where they are interpreted and discussed in relation to the academic literature and practical implications.

Section 7.1 to 7.4 provide the main cross-case synthesis, comparing the Netherlands and the United Kingdom along each framework dimension. Section 7.5 integrates the findings by identifying a small set of cross-cutting explanatory mechanisms that explain the most important similarities and differences between the two cases.

7.1. Vertical coordination across governance levels

7.1.1. Vertical responsibility allocation along the process

Both governance systems follow a similar funnel structure. Strategic spatial steering narrows the feasible development space, project-level studies generate the safety evidence base and consenting translates that evidence into binding conditions that are implemented downstream. The key difference is where the funnel is controlled most tightly (plan-led versus evidence-led steering) and who carries the main burden for producing and defending navigational safety requirements.

In the Netherlands, vertical responsibility is concentrated in the state across the first two funnel stages. The plan layer (Program North Sea) provides strong upstream steering by designating wind energy areas while avoiding conflicts with (internationally anchored) shipping routes. This upstream allocation is then operationalised through state-prepared project instruments (NRD/EIA and the site decision) that translate strategic choices into site-specific and legally binding conditions. In practice, this means that key requirements affecting navigational safety (for instance, layout-related constraints or corridor requirements) are shaped and formalised before developers enter the later stages. The sequencing is

explicitly designed to prevent navigational conflicts from showing up only after projects have already become difficult and costly to change and to avoid “permit chaos” through early stabilisation of expectations.

In the United Kingdom, vertical steering is more split across institutions and less plan-led. Marine plans (made by the MMO) provide a policy baseline, but they do not operate as a tightly binding spatial instrument in the same way as Dutch marine plans. Instead, major spatial narrowing occurs through The Crown Estate's leasing rounds, which function as an upstream gatekeeping process refined with consultee input and with the goal to create revenue for the state. After leasing, the process becomes more developer-led. Developers initiate scoping and produce most of the project evidence, including navigational risk work. Maritime safety regulators and planning bodies influence outcomes through consultation, written representations and the shaping of conditions that must be legible and defensible in the consenting record. Because final consenting authority sits outside the maritime safety regulator (for NSIPs), vertical influence is exercised largely through the quality of evidence and its translation into enforceable consent and marine licence conditions.

The mechanism linking these differences to safety outcomes is *lock-in and risk-bearing*. Because the Dutch system concentrates vertical responsibility in state-led designation and state-prepared instruments, key avoidance choices and safety requirements are stabilised early. They are then carried forward as a pre-specified, legally binding package within a bounded development area. Therefore, the main risk-bearing and justification effort is pushed upstream, while later phases primarily refine within limits and demonstrate compliance with conditions. This leads to earlier lock-in of navigational safety constraints and reduces the likelihood that fundamental conflicts re-emerge late in ways that require major redesign.

Comparatively, the Dutch model is front-loaded. Safety-relevant constraints are stabilised upstream through national planning and site preparation, which reduces late-stage surprises but makes later changes expensive. The UK model relies more on leasing followed by developer-led assessment and examination, pushing more residual risk management into stages where evidence must withstand scrutiny and be translated into robust consent conditions. This preserves flexibility longer, but increases sensitivity to late-stage evidence quality and raises the risk of late redesign or denial. In both cases, the vertical allocation of responsibility shapes when safety becomes “fixed”, who bears the cost of demonstrating proportional mitigation and where the principal risk of late redesign or denial is concentrated.

This matters for the next subsection because the extent to which steering can be settled upstream depends on what is treated as non-negotiable across governance levels, which in turn shapes how much safety is resolved through early designation versus later evidence justification.

7.1.2. International baseline: binding constraints vs discretionary guidance

In both cases, international maritime regulation establishes a shared, non-negotiable baseline that constrains national freedom of action in the EEZ. The key difference is not the existence of these “hard lines,” but how each system handles the remainder of offshore wind shipping safety. That is, where the space for interpretation is determined and where the consistency with the institutional frameworks is stabilized or restored.

In the Dutch case, interview evidence emphasises that international maritime law and frameworks are leading in the EEZ. This limits the extent to which the Netherlands can directly steer ship behaviour and makes significant rule change dependent on coordination beyond the national level. At the same time, a large part of safety around offshore wind is governed through non-fully binding standards and best practices. This creates interpretive room where international guidance is incomplete or does not map perfectly onto new practices. Consistency is highest where rules are prescriptive (e.g., avoid obstructing routing measures). It becomes more variable where international guidance is incomplete or emerging practices do not fit existing labels. For example, new monitoring concepts are framed in ways that avoid triggering international expectations too early. The EU layer also matters in a specific way. The MSP Directive institutionalises periodic plan revision, providing a structured route through which strategic spatial steering can be adjusted over time.

In the United Kingdom case, the same dynamic is visible through SOLAS Chapter V and IMO-adopted routing measures. They function as practical ‘red lines’ in planning and review: fixed infrastructure

should not obstruct IMO routeing measures, turning these obligations into non-negotiable siting constraints. Outside these hard constraints, however, the United Kingdom approach is characterised by layered translation. Binding IMO/SOLAS constraints define what cannot be violated, while national guidance specifies how acceptable risk should be assessed in areas that remain open to interpretation. Following EU exit, the EU MSP layer no longer structures periodic plan revision in the same way. The practical implication is less about EU safety rules and more about where the United Kingdom system chooses to stabilise coordination: through leasing, guidance development and consent translation rather than mandated plan revision cycles.

Because binding IMO/SOLAS obligations and adopted routeing measures act as non-negotiable constraints, both systems treat them as early criteria that decide the limits of siting and safety decision-making. Therefore, baseline consistency is highest where rules are prescriptive (e.g., avoiding obstruction of routeing measures) and these constraints provide a basis for defensibility when decisions are challenged. Because much of shipping safety around offshore wind is governed through non-binding guidance (e.g., IALA marking and lighting recommendations) and evolving practice, interpretive space is unavoidable. Therefore, national systems must translate incomplete guidance into operational expectations. This leads to variability (standards gaps, mismatched labels, emerging practices) and in how it is repaired (through plan revision pathways in NL versus guidance/consent translation in the United Kingdom).

For safety integration, international baselines lock in certain constraints early, reducing the scope for conflict resolution in those domains and strengthening the defensibility of siting decisions. The main risks of late redesign or denial concentrate instead in the discretionary zone. Where guidance leaves interpretive room, where standards lag behind practice and where national translation must be justified. In the Netherlands, this places weight on managing standards gaps and using plan revision cycles as a structured route for updating strategic steering. In the United Kingdom, it places weight on producing evidence and conditions that translate interpretive judgments into consentable, record-robust requirements.

This matters for the next dimension because the interpretive zone is precisely where actors must coordinate horizontally to agree on what guidance means in practice, how uncertainty is handled and which trade-offs are acceptable when international prescriptions run out.

7.2. Horizontal coordination and trade-offs

7.2.1. Actors and early entry points

In both cases, horizontal coordination is characterised by early and repeated involvement of shipping-safety and maritime stakeholders. Navigational safety is not treated as an end-of-process issue that appears only at the final permitting decision. The key difference lies in the arena through which early entry is organised and in the formal process through which safety actors later translate their input into binding requirements.

In the Netherlands, early horizontal coordination is embedded in the strategic planning stage (Program North Sea), where shipping-safety responsibilities sit primarily with IenW and are coordinated with other interdepartmental actors. This arena provides a structured platform to raise coexistence issues early and to embed safety-related principles (such as avoiding major traffic flows) before project-level design choices are made. Later, safety actors remain engaged through the formal site decision procedure, where interdepartmental actors are brought into the consenting process and where stakeholder input can result in explicit conditions attached to the site decision. As a result, Dutch horizontal coordination is comparatively embedded within state-led planning and consent-making process.

In the United Kingdom, early horizontal coordination is anchored less in binding plan-making and more in the leasing and area identification stage. Marine plans provide a policy baseline, but early steering is achieved mainly through The Crown Estate's consultation with key consultees during leasing rounds. Maritime safety enters early through the MCA and specialist bodies such as Trinity House and the United Kingdom Hydrographic Office, which can flag problems and thereby influence choices before commercial commitments. Later-stage involvement continues primarily through consultee roles. Maritime and marine regulators influence outcomes through evidence submissions, written representations and recommended conditions that must be incorporated into the examination record and translated into

marine licence conditions. Therefore, United Kingdom horizontal coordination is strongly mediated by consultation processes and by the requirement that positions become defensible within the consenting record.

Because both systems create early entry for maritime safety actors, they enable safety considerations to shape the solution space before projects reach stages where change becomes costly. Therefore, safety is integrated not only through late-stage conditions but also through upstream coordination that narrows options and sets expectations. Because the Dutch early arena is centred on interdepartmental planning, horizontal coordination is more tightly coupled to state-led steering and can be translated into binding requirements through the site decision process. This leads to coordination that is comparatively stabilised through internal government alignment and then carried into consent instruments. Because the United Kingdom early arena is centred on leasing consultation and later relies on statutory consultee interventions in consenting, coordination is more dependent on how constraints and trade-offs are argued, evidenced and documented in the record. This leads to a stronger emphasis on evidence production and condition formulation as the mechanism through which horizontal coordination influences outcomes.

For safety integration, early and repeated stakeholder involvement reduces the chance that navigational safety emerges as a late surprise in either system, but the timing and form of lock-in differ. In the Netherlands, early coordination embedded in state planning can lock in avoidance principles and translate them into binding site conditions. In the United Kingdom, early involvement can influence leasing choices, yet a larger share of defensibility is constructed later through record-based scrutiny and enforceable conditions. This preserves flexibility longer but raises the stakes of late-stage evidence contestation and the risk of delay or denial if coordination does not translate into requirements.

This matters for the next subsection because the arena and pathway of coordination shape how trade-offs are negotiated. Whether they are settled through upstream alignment and pre-specified requirements or whether they must be repeatedly justified and converted into defensible conditions under consultation and examination.

7.2.2. Coordination mechanisms: formal and informal arenas

Across both cases, horizontal coordination is achieved through a mix of formal procedural arenas and informal pre-alignment. The formal arenas provide transparency, legal traceability and decision legitimacy, while informal arenas create flexibility to identify constraints and converge on feasible solutions before positions harden. The key difference is where each system places the main coordination load: the Dutch case embeds coordination more in recurring, state-centred planning and site-decision machinery, whereas the United Kingdom case relies more on consultation sequences that must ultimately become legible in the consenting record.

Coordination mechanisms

Formal horizontal coordination in both cases is organised through procedural arenas that make sectoral claims visible, comparable and legally traceable. These arenas do not just only provide input, they structure how navigational safety concerns are translated into redesign requests, evidence requirements and enforceable conditions. The cross-case difference is less about the existence of formal procedures and more about the form that traceability takes. Recurring state-centred platforms and appeal-safe consultation windows in the Netherlands versus record-based consultation, examination and condition drafting in the United Kingdom.

In the Netherlands, formal coordination is anchored in three interlocking arenas. First, strategic planning consultation within the North Sea Programme provides a structured setting in which interdepartmental actors and sectoral stakeholders can raise coexistence issues and test spatial claims before they become attached to specific project layouts. Second, project-level consultation windows in the site decision procedure, notably the NRD (draft and final) and the *kavelbesluit* (draft and final) institutionalise moments in which stakeholders can submit views and appeal to outcomes. These windows matter horizontally because they force the explicit articulation of safety concerns and the justification of responses in a traceable and contestable format. Third, recurring coordination platforms such as the Noordzee Overleg (NZO) and the Shipping Advisory North Sea (SAN) provide continuity across projects and sectors by offering stable arenas for alignment, escalation and the management of issues

that do not fit within a single project procedure.

In the United Kingdom, formal coordination is organised through consultation and record mechanisms that progressively harden positions into consentable requirements. Upstream, leasing-stage consultation and screening led by The Crown Estate involves regulators and specialist consultees in order to flag navigational constraints and test feasibility before commercial commitments. Downstream, statutory consultation through the EIA process provides a formal channel for sector bodies and authorities to submit written inputs and requests for modification that must be addressed. Within this process, the NRA functions as a coordination mechanism by standardising how navigational risk, mitigation and residual acceptability are discussed across actors. For NSIPs, examination and condition-setting then consolidate these interactions into the formal record. There, recommended safety provisions are translated into enforceable consent and marine licence conditions.

In both systems, interview evidence highlights the importance of informal coordination. Informal working groups and expert meetings are used to prepare positions, align assumptions and identify feasible mitigation before the formal procedure raises the stakes of conflict resolution. In the Netherlands, this pre-alignment reduces the likelihood that major disagreements surface late in consultation or appeal. In the United Kingdom, pre-application engagement and informal meetings between developers and key consultees have a similar function by testing feasibility and identifying navigation problems before submission. In both cases, informal coordination operates as a flexibility layer that narrows the set of issues that must be fought out formally, allowing formal procedures to focus on settling residual disagreements in a way that is traceable and enforceable.

Power and influence: decision rights, evidence and translation into conditions

The two cases differ most sharply in how horizontal influence is exercised. In both systems, many actors participate, but their ability to shape outcomes depends on formal decision rights, control over evidence and the credibility of safety claims and the capacity to translate agreements into enforceable obligations.

In the Netherlands, horizontal influence is strengthened by formal gatekeeping within the site-decision process. The Ministry of Infrastructure & Water Management participates directly in producing and approving the *kavelbesluit* and co-signing creates a concrete leverage point. Unresolved issues cannot simply be bypassed if a required signature is not given. However, this leverage does not imply an unrestricted veto. Interview evidence indicates that positions must be justified as proportional and reasonable, which means that influence depends on whether concerns can be translated into defensible requirements rather than expressed just opposition. In practice, power is exercised through the ability to translate sectoral concerns into conditions that can withstand discussions and potential appeal.

In the United Kingdom, maritime and marine authorities typically hold voice rather than final decision power for NSIPs. The consenting decision is taken by the Secretary of State following examination. The MCA and MMO influence outcomes as statutory consultees, but the decision-maker can weigh navigational safety alongside other national policy objectives and may ignore consultee preferences. This institutional configuration reduces the likelihood that any single sector body can block a project and shifts influence toward what can be demonstrated and defended in the evidence record. As a result, horizontal power is concentrated in shaping quantified risk arguments and in ensuring that these arguments are translated into specific, enforceable consent and marine licence conditions.

Evidence is decisive in both systems, but it functions through different routes. In the Dutch case, influence is exercised mainly through co-signing with a solid evidence bases. Other stakeholders gain leverage by challenging assumptions, proportionality and feasibility. In the United Kingdom case, evidence and quantification become even more central because consultees lack signing power. Recommendations must be clear, evidence supported and usable for inspectors. The NRA provides a shared format for debating navigational risk, mitigation and residual acceptability. This creates an “evidence politics” dynamic in which actors gain influence when they can credibly show that a design or mitigation package is insufficient or that additional measures are proportionate and implementable.

Taken together, the comparison suggests that horizontal coordination depends not only on participation, but on the interaction between decision rights, evidence credibility and translation capacity. The Dutch case consolidates influence through institutional involvement in producing the site decision and through

procedural channels that link stakeholder inputs to binding conditions. The United Kingdom case consolidates influence through polycentric consultation in which influence is mediated by the quality of the evidence and by the ability to convert it into enforceable requirements. In both systems, the most influential actors are those who can connect sectoral concerns to concrete redesign and to conditions that remain operationally meaningful and defensible under formal scrutiny.

7.2.3. Coordination challenges: polycentric governance and shared data baselines

A final horizontal dimension concerns the extent to which each system aligns programmes and stabilises shared interests. Both cases are polycentric in the sense that multiple organisations hold partial responsibilities and pursue different sectoral objectives. However, the consequences of the polycentric system differ because the systems provide different mechanisms. Polycentricity is therefore a potential strength and a potential weakness. It can strengthen governance by providing checks and balances, multiple knowledge sources and opportunities for mutual control. But it can also weaken governance by fragmenting accountability, multiplying interfaces and turning technical disagreements into institutional hiccups. The consequences depend on whether the system has mechanisms that stabilise shared baselines and align programmes across organisations.

In the United Kingdom case, interview evidence describes marine spatial planning and offshore wind governance as fragmented. Multiple programmes and institutions operate in parallel (e.g., marine plans, leasing, consenting routes and additional optimisation initiatives) without a single actor that is responsible for integrating trade-offs across the system. In this setting, polycentricity tends to manifest as a coordination weakness. When no actor can settle contested assumptions authoritatively, disagreements over traffic evidence, modelling choices or spatial baselines can escalate into institutional disagreement. Coordination then depends heavily on consultation capacity and on the ability to produce a defensible record that can carry competing claims. This makes shared data baselines a critical resource. Empirically, the growing emphasis on linking data platforms and improving data sharing (notably between the MMO and The Crown Estate) can be seen as an attempt to make polycentric governance workable by reducing disputes over inputs, improving the comparability of claims and lowering the coordination burden that would otherwise be pushed into project-by-project negotiation.

The Dutch system is also polycentric. Multiple ministries, agencies and sectoral stakeholders interact around offshore wind, shipping, fisheries, oil and gas, defence and environmental objectives. However, interview evidence suggests that polycentricity sometimes also functions as a governance strength in the Dutch system, because it is coupled to stabilising mechanisms that structure interaction. When the right mechanisms structure the interaction and collaboration, the system can create checks and balances. Rather than one actor unilaterally prioritising a single objective, multiple departments and advisory arenas provide counterweights that can improve the legitimacy and robustness of outcomes, especially when trade-offs are politically sensitive. At the same time, the Dutch case also illustrates the weakness side of polycentric governance. More centres of authority also mean more interfaces and more work to maintain alignment, especially when new practices emerge and standards lag behind reality. The difference is that the Dutch system appears to have stronger coupling capacity, through recurring arenas and clearer institutional pathways for alignment. This limits the risk that disagreements remain unresolved or reappear as late-stage objections.

Taken together, the comparison suggests that the key question is not whether governance is polycentric, but whether polycentricity is managed as a strength or experienced as a weakness. Where coordination mechanisms stabilise shared baselines and provide arenas for alignment, polycentricity can improve checks and balances, legitimacy and robustness. Where such mechanisms are weaker, polycentricity increases reliance on consultation capacity, data coupling and record-based dispute resolution to compensate for fragmentation. In practical terms, this makes data infrastructure and the standardisation of assumptions especially consequential in the United Kingdom case. The Dutch case shares the same challenge, but is more often mediated through institutionalised coordination that converts polycentric diversity into structured negotiation rather than persistent fragmentation.

7.3. Timing and mode of safety integration (Safety-I vs Safety-II)

This section compares how shipping safety is governed over time in each case; what makes safety important at the system level, when safety enters the decision chain, which safety logic dominates and to what extent learning and adaptive capacity are institutionalised. Where previous sections compared the allocation of responsibility and the organisation of coordination, the focus here is the safety mode itself: predominantly Safety-I versus emerging Safety-II.

7.3.1. Major-accident triggers: what forces system-wide thinking?

As introduced in Chapter 1 major incidents can function as a trigger for more attention for safety by making vulnerabilities in the system visible, increasing political attention and strengthening the mandate of safety actors. In practice, this trigger matters because it shapes when safety concerns carry weight in decision-making and whether governance remains project-by-project (Safety-I) or shifts toward more anticipatory, system-level approaches (Safety-II).

In the Netherlands, OVV oversight functions as a practical trigger mechanism. Incidents combined with independent investigation create formal accountability via ministerial response obligations. This can raise political attention and strengthen the mandate and resources for more systemic approaches. In the empirical material, this is reflected in a move toward forward-looking scenario work, greater demand for quantification and indicators and the development of more testable (verifiable) safety goals. Importantly, the trigger effect is not limited to interpretive learning. It also supports more operational Safety-II elements, where monitoring and intervention capacity (e.g., VTMon, ERTVs) becomes part of the governance response rather than remaining solely a project-level mitigation issue.

In the United Kingdom, the empirical material suggests there has not been a defining major accident trigger in offshore renewables that forces actors to identify major-accident potential and demonstrate its awareness through a dedicated, recurring framework. As a result, navigational safety becomes the most formalised component of risk governance because it has established routines and evidentiary expectations (e.g., NRAs and a defensible consultation record). Broader hazard identification remains less systematised and more dependent on documentation practices, guidance and voluntary standards. This aligns with the DNV white paper [11], which states that offshore renewables should be treated as a major-accident industry but currently lacks a system-wide approach. DNV explicitly warns not to wait for a defining incident to tighten governance, explaining that historically such regime shifts have often followed disasters (e.g., Piper Alpha).

At the same time, trigger-driven influence is sensitive to attention cycles. When no new incidents happen and political attention declines, safety actors become more dependent on formalised mechanisms and verifiable evidence to maintain influence. This creates an opportunity. Safety-II elements are not only about learning. They can also help sustain governance capacity by making future and cumulative risks visible in defensible terms. Without this combination of institutional embedding and anticipatory evidence, coordination pressures can go back to project-by-project compliance, with less upstream alignment on cumulative system risks.

Where trigger mechanisms institutionalise system-wide attention, safety integration is less vulnerable to attention cycles. Requirements for indicators, monitoring and adaptive measures can persist even when no new incidents occur. Where such triggers are weaker, safety actors may become more dependent on formalised evidence and verifiable arguments to maintain influence, increasing the weight placed on defensibility at the project level. In both cases, Safety-II elements matter not only for learning, but for sustaining governance capacity by keeping cumulative risk visible before it becomes a late-stage dispute or a denial risk.

This matters for the next subsection because the presence (or absence) of sustained system-level triggers shapes where adaptive capacity is anchored in the decision chain. In standardised expectations and monitoring arrangements or primarily in case-by-case evidence and consent conditions.

7.3.2. Entry points and sequencing along the decision chain

Building on the trigger dynamic described above, the cases differ in where safety first becomes binding and how it is carried through the decision chain. Both systems integrate shipping safety early, but through different entry points and with different implications for later adaptation.

In the Dutch case, safety enters most explicitly through plan-led steering. The North Sea Programme sets early spatial boundary conditions and reduces the likelihood of major route conflicts. These early choices are then translated into binding, site-specific requirements through NRD/EIA scoping and the kavelbesluit. This shifts safety upstream and reduces the need for late-stage redesign or reactive mitigation once projects are committed.

In the United Kingdom, safety also enters early, but primarily through the upstream leasing funnel. The Crown Estate's screening and consultee input (mainly the MCA) shape the solution space before projects move to project consenting. However, after leasing the safety integration moves downstream into developer-led risk assessments through the NRA and the consenting record. In other words, early safety is largely screening and exclusion, while later safety is proof and translation into consent conditions. This order strengthens project-level Safety-I assurance, but it makes system-wide anticipation more dependent on how much is taken into account in upstream screening requirements.

7.3.3. Safety-I as the dominant operating logic: compliance, baselines and risk acceptability

Across both cases, the most visible safety logic remains Safety-I. Safety is operationalised through minimum requirements and project-level risk assessment showing that residual risk is acceptable once mitigations are applied. In practice, this logic is relatively project focused. It is strongest where risks can be specified, modelled and assessed at the scale of a single project and its local traffic interactions. It also provides a defensible basis for decision-making, which becomes particularly important when system-wide triggers are absent or when political attention for safety declines.

In the Netherlands, Safety-I similarly remains the baseline, but it is framed more explicitly as a boundary condition. Projects should not proceed if a decrease in safety cannot be ruled out or managed in a defensible way. This is implemented through early spatial avoidance, formal assessments and enforceable permit conditions. Dutch interviews emphasise that early integration is possible even when knowledge is incomplete. Robustness depends on the maturity and credibility of the evidence rather than on procedure alone. As a result, Safety-I in practice often relies on bounded evidence (models combined with expert judgement) and defensible reasoning, rather than aiming for complete certainty.

In the United Kingdom, interview and document evidence describe a Safety-I framing centred on collision risk. Projects quantify likelihood using baseline versus "with project" comparisons and then reduce risk through layout changes and operational mitigation. Prescriptive baseline (avoiding IMO routing measures, protecting port access, marking standards) define non-negotiable boundaries, while NRA performance arguments fill the remaining space. This demonstrates acceptability at project level, but it also means that wider risk identification and system-wide risk thinking remain less formalised than the collision-risk focus of the NRA.

7.3.4. Emerging Safety-II: learning loops, adaptive updates and operational resilience

Across both cases, Safety-II is emerging, but it is seen in different ways and with different system-wide ambition. Consistent with the trigger dynamics described above, the Dutch case shows a shift toward Safety-II practices in response to scale-up pressure and concrete 'wake-up' moments. The Julietta D incident (2022) and subsequent OVV recommendations (2024) increased political attention and created momentum to complement project-by-project compliance with more system-level understanding. Interviews link this shift to increased focus on modelling, scenario thinking, periodic evaluation and the forming of a more testable safety goal.

Interviewees describe emerging efforts in three areas: Stronger emphasis on forward-looking scenario work and traffic projections, increasing demand for quantification and indicators (to justify measures that are costly or affect the business case) and building an operational resilience layer through monitoring and timely intervention capacity (e.g., VTMon and ERTVs). A key interview implication is that Safety-II practices give legitimacy under uncertainty. Because major incidents are rare, near-misses and scenario-based evidence become important for making future risks visible and for justifying investment in capability and oversight. In this sense, Safety-II is not only about learning, it also strengthens the justification of measures by making future and cumulative risks more visible.

In the United Kingdom case, Safety-II appears less as system-wide anticipatory risk governance and more as process adaptation and incremental learning cycles. Two learning loops stand out. First, learning is visible upstream in the leasing process. Recent leasing rounds have become more evidence-intensive (e.g., Round 5's more thorough screening and refinement) to reduce downstream consenting risk and late redesign costs. This is a Safety-II style change that adapts the system design based on experience of what caused failure (delay, rework, refusal risk). Second, learning occurs through adaptive guidance updates. Interviews describe revisions of MCA guidance (MGN updates) "according to experience", including changes in layout as turbines scale up and SAR needs change. Interview Fox-trot also describes a broader review ("nothing is fixed"), showing that the system is being revised based on experience across multiple domains. However, this adaptive attitude is still anchored in a largely project-level risk management model. It does not (yet) suggest a system-wide major-accident style regime for offshore renewables. Cumulative considerations therefore remain comparatively bounded and are often operationalised through limited-area assessments around individual projects rather than through system-level scenario governance.

Relative to the UK, the Netherlands shows more visible anticipatory Safety-II elements emerging. "Wake-up" moments and OVV follow-up have strengthened scenario thinking, forward-looking traffic projections, periodic evaluation and a move toward more testable safety goals. In the United Kingdom, Safety-II appears more as iterative process adaptation. Learning is expressed through more evidence-intensive leasing refinement and through incremental updates to guidance as turbine scales, layouts and SAR-needs evolve. The underlying risk model remains largely project-based rather than framed as a dedicated, system-wide major-accident regime.

For safety integration, the implication is that where these Safety-II elements are applied, they can make future and cumulative risks more legible and justifiable, supporting earlier investment in capability and reducing reliance on project-by-project argumentation under uncertainty. In the United Kingdom, Safety-II primarily strengthens the system by lowering consenting friction and redesign risk through improved screening and guidance, but cumulative risk governance remains weak. Overall, Safety-II in the Dutch case appears mainly as a complementary evidence-building capability alongside a still-dominant Safety-I baseline, rather than a replacement logic.

7.3.5. Uncertainty and future system change

A core contrast between the cases concerns how uncertainty about future traffic patterns and cumulative change is treated. In the Netherlands, interviews highlight that early procedural integration does not remove the problem of incomplete knowledge. However, Dutch interviews suggest that some actors and initiatives are moving more explicitly toward anticipation. It shows scenario-based analysis to test if requirements and resources are sufficient under the uncertain future and a push for tracking of safety performance as the sea becomes denser. This reflects an emerging shift from demonstrating safety for a single project configuration toward governing uncertainty as a system condition.

In the United Kingdom, uncertainty is acknowledged but handled in a bounded, project-level way. Long-term scenario modelling does not show up as an important practice in the empirical material. Instead, interviews suggest that future conditions are often represented through consultant growth assumptions and extrapolation within project NRAs. Interview evidence also points to institutional uncertainty created by parallel planning programmes (leasing, marine planning, energy planning), which can change long-term spatial expectations. The practical outcome is a focus on design robustness and mitigation rather than anticipatory, system-wide thinking or cumulative risk.

In sum, the United Kingdom treats uncertainty mainly as an input to project assessments. The Netherlands shows increasing effort to treat uncertainty as a driver for system-level anticipation and performance-based adjustment.

7.4. Dual-layer compliance structure

7.4.1. Prescriptive baseline: non-negotiables and hard constraints

Both cases apply a first compliance layer that functions as a prescriptive baseline. A set of non-negotiable constraints and minimum technical/procedural requirements that define what designs cannot violate. This layer creates stability and predictability for regulators and developers by setting clear

boundaries before project-specific trade-offs are considered.

In the Dutch case, the prescriptive baseline is anchored partly upstream through spatial steering and partly through minimum operational constraints around access and behaviour. A central baseline instrument is the use of distance buffers between offshore wind and major shipping structures. As a default planning rule, the Netherlands applies a minimum distance of two nautical miles between wind farms and (inter)nationally recognised routeing measures, anchorage areas and clearways. Beyond setting a minimum stand-off, this Dutch distance framework also gives power in horizontal coordination. It gives safety actors a shared reference point that spatial layouts are no longer a matter of preference but of maintaining manoeuvring space and defensible drift margins. This baseline is complemented by internationally anchored marking and lighting requirements.

Beyond siting and visibility, Dutch baseline constraints also govern access. Passage through some wind farms is possible only in tightly defined ways. Certain restrictions are treated as non-negotiable boundary conditions. A prominent example is the anchoring ban in wind farm areas, justified by both navigation safety and infrastructure protection. Together, these elements show the Dutch baseline logic. Constrain risk primarily by shaping spatial and access conditions in the EEZ, where direct behavioural regulation is limited.

In the United Kingdom case, the baseline layer is described in interviews as a set of siting principles and minimum operational requirements. Core siting principles function as hard constraints (e.g., do not site on IMO routeing measures, protect port access). They are often operationalised through a two-nautical-miles distance expectation around key routeing measures. Similarly, the United Kingdom distance expectations operate as a practical “distance-risk” framework. The framework is often used as benchmark and it provides regulators with a structured basis to request redesign, additional mitigation or stronger justification in the NRA. Deviations require solid justification. The baseline also includes minimum requirements for marking/lighting and aids to navigation.

An important United Kingdom baseline feature is the norm of open navigation after construction. Operational wind farms are not exclusion zones and vessels are expected to keep distance from individual turbines (a 50 meter clearance is mentioned in interviews). Formal safety zones are used primarily during construction (e.g., 500 m around structures). This baseline openness is complemented by prescriptive expectations that enable emergency operations (e.g., layout and access considerations), while leaving design details to the performance layer.

Across both cases, the prescriptive baseline is most visible in spatial non-negotiables (routeing measures, port approaches, minimum stand-offs), visibility requirements (marking/lighting anchored in IALA guidance) and procedures. The key difference is where the baseline is stabilised. The Dutch baseline is more strongly embedded through plan-led spatial allocation and nationally anchored access constraints.

7.4.2. Performance-based demonstration: how acceptability is shown

In both cases, compliance does not end with meeting a prescriptive baseline. A second, performance-based layer determines acceptability through a project-specific demonstration that residual risk is tolerable under the proposed design, supported by mitigation and consultation. This layer creates negotiated flexibility. Within hard constraints, actors adjust layouts, corridors and operational measures until the risk outcome is acceptable. The key difference is how this performance logic is anchored institutionally and where the proof burden sits.

In the Netherlands, the performance-based layer is operationalised through NRD/EIA and site-decisions that connect assessed shipping impacts to design choices and enforceable requirements. Importantly, the prescriptive baseline itself contains a performance element. Interview and document evidence indicate that the two-nautical-miles buffer can be adjusted based on site-specific traffic and incident analyses. The baseline is tested against local traffic density and risk characteristics. A second performance dimension becomes visible through multi-use ambitions. As wind farm areas are increasingly seen as candidates for multi-use rather than exclusive zones, the governance shifts from excluding activity to demonstrating safe coexistence is possible. In this context, corridors and AIS-based access rules operate as performance-style measures. Rather than prohibiting all activity, they bundle traffic into predictable lanes and increase observability (AIS carriage, monitoring) so residual risk can be managed.

Interview material also shows that access discussions may extend to allowing fishing within wind farms on a project-by-project basis if permits can be justified. At the same time, Dutch interviews emphasise that this performance layer remains bounded in practice. Maritime safety is treated as a precondition, but proportionality is difficult to demonstrate and quantification remains bounded. Therefore it relies on bounded evidence (models combined with expert judgement) and defensible reasonableness rather than full elimination of uncertainty.

In the United Kingdom, the performance layer is institutionalised in the NRA and the associated consultation and documentary record. Developers quantify collision risk and compare baseline to “with project” (or worst-case) designs. Then they propose mitigation and redesign until risk is judged acceptable (often framed through an ALARP logic). A key mechanism is that baseline rules (e.g., distance expectations) can operate as a starting point. The baseline is still two nautical miles from traffic separation schemes, but cases closer to other routing measures are assessed through a distance/risk framework that shifts the decision question from rule compliance to evidence-based judgement. Where collision likelihood increases, developers are expected to redesign through corridor and layout modifications. Authorities do not “design the layout” themselves, but set parameters that the design must satisfy (e.g., requirements that support SAR helicopter operations with at least one corridor), leaving developers to produce both the solution and the evidentiary trail. The same dual-layer logic is also visible upstream in leasing design, reinforcing the repeated pattern of baselines plus a negotiated performance space across the United Kingdom chain. Interviewees emphasize that in general, where there is not prescriptive law, they tend to use performance-based regulations.

Because prescriptive law and standards cannot fully cover changing local traffic condition and because actors default to performance-based regulation where prescriptive rules are absent, both systems rely on a performance layer that converts safety objectives into site-specific justification. Therefore, acceptability is produced through an evidence-supported interaction in which stakeholders discuss assumptions, developers iterate layouts and mitigations and authorities assess whether residual risk is acceptable. This leads to structured flexibility. Designs can vary across sites, but only to the extent that risk is considered defensible.

For safety integration, this means that the performance layer is not just an extra on top of hard rules. It is often the main governance mechanism precisely where prescriptive guidance runs out. This places greater weight on evidence quality, shared assumptions and the enforceability of condition wording. It also concentrates redesign pressure in the performance layer. When modelling choices, baseline data or mitigation effectiveness are challenged, resolving the dispute typically requires additional work, tighter conditions or layout changes. This increases risks of delay or denial if acceptability cannot be established convincingly. Cross-case, defensibility depends on whether the performance demonstration can resist examination. In the United Kingdom, this concentrates around developer proof through the NRA and record-based condition drafting. In the Netherlands, performance justification is more bounded by pre-specified requirements, but becomes increasingly influential where coexistence and density make simple exclusion less feasible.

7.5. Cross-case synthesis: what explains the differences?

Sections 7.1–7.4 compared the Netherlands and the United Kingdom along the analytical framework. This section integrates those findings by identifying a few cross-cutting mechanisms that come back across dimensions and jointly explain why the two systems produce different patterns of safety integration, evidence production and trade-off resolution. The aim is to show how spatial steering, institutional decision rights and learning dynamics interact to shape where risk is managed and how safety claims become persuasive and defensible.

7.5.1. Three cross-cutting mechanisms

The following propositions summarise the most important explanatory mechanisms observed across both cases. They are written as empirically grounded tendencies rather than normative recommendations.

Proposition 1: Centralised plan steering vs fragmented planning shifts where safety is managed

Where offshore wind development is coordinated through a central marine spatial plan with clear up-

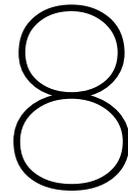
stream choices (NL), navigational safety is stabilised early through avoidance principles and a bounded development area. This tends to push the most difficult safety decisions upstream and reduces the chance that large route conflicts show up late, when redesign is costly. Where planning is more fragmented and not the integrator for large projects (United Kingdom), similar safety outcomes are achieved through alternative processes and through stronger reliance on project-level proof and negotiation. In practice, fragmented planning therefore increases the risk of delay or denial in consenting and puts more pressure on downstream assessment quality to defend solutions once projects are committed.

Proposition 2: Decision power does not remove evidence politics, it reconfigures it

In the United Kingdom, the absence of maritime veto power means safety influence depends heavily on producing record-proof claims. Data quality, quantification and documentation become central because they enable inspectors and decision-makers to rely on consultee advice when weighing safety against other policy objectives. In the Netherlands, formal gatekeeping (e.g., co-signing) strengthens the position of safety actors, but it does not translate into unlimited veto power. Influence remains constrained by expectations of proportionality and reasonableness. As a result, quantified evidence and measurable parameters also matter in the Dutch case, because they translate objections into defensible requirements rather than absolute opposition. In both systems, power operates through evidence, either because actors lack veto authority (UK) or because veto authority is practically bounded by what can be justified as proportionate (NL).

Proposition 3: Safety-II learning loops supply the evidence that shapes future-oriented safety governance

Across both cases, Safety-I compliance and project-level risk acceptability remain the dominant mode. However, learning loops decide whether the system can anticipate cumulative risk and future traffic change. Where learning is institutionalised mainly as process improvement (United Kingdom), Safety-II tends to appear as refinement of upstream screening and guidance updates. This strengthens the pipeline without necessarily creating a system-wide anticipatory risk model. Where stronger triggers and oversight cycles exist (NL), Safety-II expands further into scenario work, indicators and operational monitoring. This produces the evidence base that makes future risks visible and supports justification of costly or restrictive measures. In this sense, Safety-II does not only 'add learning', it provides an evidence foundation for claims across projects and enables safety actors to argue for measures that cannot be justified by historical accident rates alone.



Conclusion and discussion

This chapter discusses what the thesis findings mean beyond describing the two cases individually. Chapter 7 compared the Netherlands and the United Kingdom along the four analytical dimensions. Here, the chapter first summarises the empirical patterns from the comparison, after which the discussion links these patterns back to the literature and practice. The central argument is not that any single dimension explains outcomes on its own, but that the interaction between these four dimensions shapes when safety concerns become steering, how they are evidenced and which actors can effectively influence offshore wind decisions.

First, the chapter summarises the cross-case takeaways in 8.1. Then it answers the four sub-questions in 8.2. Next, it integrates the answers into one answer to the main question in 8.3. The chapter then translates this into practical implications in 8.4 and with academic contributions/limits in 8.5

8.1. Main findings

This chapter shows that navigational safety is not simply added to offshore wind governance. It is built in over time through where alignment is created, when commitments become difficult to reverse and how safety concerns are converted into binding requirements. Across the two cases, the Netherlands and the United Kingdom integrate safety through different governance processes and these differences shape both the timing and the form of safety influence. A full cross-case mapping of these governance-chain differences is provided in Appendix A (Table A.1).

In the Netherlands, alignment around navigational safety is stabilised relatively upstream. Plan-led steering and binding site-decision conditions make safety requirements part of the early boundary-setting of what is feasible. This contributes to an earlier and stronger lock-in. The most consequential moment occurs at plan-level designation, where the project space is narrowed and later stages focus more on implementing within those conditions. The evidence basis that substantiate these decisions is also more state-organised. Government-led site preparation and shared baselines reduce the extent to which safety becomes a project-by-project discussion.

In the United Kingdom, by contrast, alignment is stabilised more downstream. Safety concerns are translated into acceptable terms largely through developer-led proof and the consent record. Lock-in therefore increases later. Commercial commitment grows after lease award and procedural lock-in intensifies during examination. This shifts when safety concerns must be raised to remain influential. This governance process places a larger focus on developer-produced assessments and makes review capacity, scrutiny and consultation processes central to whether safety issues are resolved convincingly.

These differences also shape how safety authority is exercised. In the Dutch case, maritime safety influence is channelled through clearer formal leverage, including inter-ministerial resolution and co-signing that can function as an upstream gatekeeper for safety. In the United Kingdom, maritime safety actors influence outcomes primarily as consultees. Leverage is generated through defensible recommen-

dations and how these are taken up in the official record rather than through explicit blocking power. In practice, this shifts attention to the politics of evidence and the robustness of documentation and responses.

Finally, system-wide anticipation depends on the presence of triggers and the availability of a shared evidence base. In the Netherlands, incidents and OVV oversight created mandate and momentum for more forward-looking and anticipatory approaches. In the United Kingdom, in the absence of a comparable trigger, coordination depends more on consultation capacity and the gradual improvement of shared evidence base to reduce recurrent contestation across projects.

Taken together, these findings explain why similar navigational safety concerns translate into early spatial steering and boundary conditions in the Netherlands, but more often emerge as consent-stage negotiation and mitigation in the United Kingdom. The next section uses these contrasts to answer the sub-questions, before integrating them into a single explanation of how governance processes shape navigational safety over time.

8.2. Answers to the research questions

This section answers the four sub-questions by comparing the Netherlands and the United Kingdom along the governance mechanisms identified in the analysis. Each subsection specifies the mechanism through which navigational safety is integrated, shows how this differs between the two cases and explains why the difference matters for when and how safety concerns translate into binding requirements.

8.2.1. Vertical coordination across governance levels

The first sub-question is:

How are responsibilities and safety requirements coordinated across governance levels (international, national, regional), and how has the delegation of responsibility evolved over time?

Across both cases, international requirements (e.g., IMO/SOLAS routing measures and IALA guidance) provide a common baseline. The key difference lies in which national steering instrument translates that baseline into binding project constraints, and therefore where in the governance chain responsibilities for defining, evidencing and resolving navigational safety are concentrated.

In the Netherlands, vertical coordination is stabilised through a central, plan-led spatial planning chain. International constraints are translated into national spatial allocation through the Program North Sea, after which the NRD/EIA (*MER*) and the site decision translate navigational safety concerns into binding site conditions before developers enter. This concentrates responsibility for structuring the safety problem at the state level. The government defines the spatial envelope, frames the assessment scope and sets minimum conditions upstream, while developers primarily design within these pre-set constraints (see Sections 7.1).

In the United Kingdom, vertical coordination is stabilised through a more fragmented process. The main upstream steering role is played by The Crown Estate's leasing process rather than by marine plans as a leading allocator. Marine plans and national policy provide reference points, but leasing rounds screen and refine areas through consultee input and responsibility then shifts downstream. Developers lead project assessment and justification (NRA/EIA), while maritime and marine authorities influence outcomes mainly as consultees, through guidance, written representations and recommended conditions within the consenting record (as synthesised in Sections 7.1 and 7.2).

The comparative mechanism is that the leading vertical steering instrument determines where safety alignment is stabilised and where the main work of risk management is done. In the Dutch system, upstream MSP and state-led site preparation stabilise navigational safety early by embedding it in area designation and binding site conditions. In the United Kingdom system, leasing provides upstream screening, but most stability is created later through developer-led proof and the evidence trail of consenting. This matters because it shifts the timing at which safety concerns must be raised to remain influential, the distribution of evidence burden and the capacity bottleneck (upstream coordination and preparation versus downstream examination and consultation).

In both cases, vertical allocation has changed over time in response to experienced friction in earlier projects, but in different ways. In the Netherlands, earlier permit-driven development generated overlap, disputes and late-stage conflict. This caused a transition towards a more state-steered model (the Offshore Wind Energy Act) in which spatial choices and safety-relevant constraints are made earlier. In the United Kingdom, experience with consenting risk, late redesign and project denials has led to more systematic constraint resolution earlier in the chain. This is visible in more structured leasing-stage screening and refinement, while the post-lease phase remains centred on developer-led assessment and justification.

8.2.2. Horizontal coordination mechanisms

The second sub-question is:

How do formal and informal coordination mechanisms structure interactions between sectors in offshore wind planning, and how does sectoral influence shape safety-related trade-offs?

Across both cases, horizontal coordination combines formal arenas (institutionalised consultation and decision procedures) with informal pre-alignment (working groups, bilateral meetings, early engagement). The mechanism that matters is when and how these arenas create alignment. Early coordination reduces late surprises and resolves disputes before projects become fixed, while late coordination pushes trade-offs into redesign and record-based negotiation (Chapter 7.4).

In the Netherlands, formal coordination is structured around plan-level consultation (North Sea Programme) and the legally staged NRD and site decision procedure. This is complemented by recurring coordination arenas (e.g., NZO and SAN), expert working groups and bilateral engagement with affected sectors. This arrangement enables sectoral knowledge (shipping routes, manoeuvring needs, port practices) to enter the process while spatial choices are still flexible and before binding site conditions are set. As a result, major navigation conflicts are more likely to be surfaced and translated into boundary conditions or design constraints upstream, rather than emerging as late-stage objections.

In the United Kingdom, formal coordination is organised through leasing-stage consultation, developer-led NRA/EIA consultation and the examination process. Informal pre-application meetings with key consultees perform an important practical function. They bring up navigation conflicts early enough for boundary or layout changes, before projects become locked into a particular pathway and procedural timetable. Compared to the Dutch plan-led approach, however, coordination is more dependent on the capacity of consultation processes and on how effectively concerns are translated into understandable recommendations that can be defended in the consenting record.

In both systems, trade-offs are typically settled through an iterative process of objection, redesign and conditional agreement. The most consequential step, however, is often upstream collaboration with impacted sectors. This is where fundamental conflicts can still be resolved through spatial steering rather than through mitigation debates after commitments are made. Sector inclusion is therefore not just procedural. It improves the quality of assessments by providing operational requirements and it increases feasibility by aligning proposed measures with practice. Early sector inclusion functions both as a safety mechanism and a process-efficiency mechanism (Sections 7.2.2).

Both cases are polycentric, meaning that authority is distributed across multiple actors rather than concentrated in a single centre. However, polycentric governance plays different roles in the two cases. In the Netherlands, the polycentric system acts not only as a coordination challenge but sometimes also as a strength. Multiple involved ministries and formalised mechanisms can create checks and balances, prevent one-sided decisions and strengthen legitimacy in politically sensitive trade-offs by enabling coalition-building (Section 7.2.3). In the United Kingdom, the absence of a single actor responsible for programme-level allocation makes coordination more dependent on consultation capacity and data sharing. In both cases, sectoral influence is strongly shaped by timing, the ability to convene actors early and the availability of convincing evidence. Even where formal leverage exists, influence depends on translating concerns into defensible and proportionate requirements.

8.2.3. Safety mode (Safety-I/Safety-II)

The third sub-question is:

How and when does shipping safety enter the offshore wind planning process, and to what extent is safety governed through a Safety-I (reactive, compliance-driven) versus Safety-II (proactive, adaptive, learning-oriented) logic?

In both cases, the dominant operating mode remains Safety-I, meaning a safety approach focused on preventing known risks through rules, compliance and project-level risk controls. Shipping safety is primarily governed through compliance with non-negotiable baselines (e.g., routeing and marking requirements) and through project-level demonstrations that navigational risk is acceptable once mitigations are applied. This logic fits legal accountability and consenting practice and it concentrates assessment on risks that can be quantified and argued within a project (Chapter 7.4).

Safety-II appears in both cases not as a replacement for this compliance-based approach, but as a complementary mode of governance focused on anticipation, adaptation, and learning. It helps actors consider how safety can be maintained in complex and evolving conditions, especially where major accidents are rare and historical accident data alone are insufficient for anticipating future risks. The key comparative mechanism is the level at which this anticipatory capacity is institutionalised.

In the Netherlands, incidents and the OVV trajectory increased political attention and created a mandate for more anticipatory safety governance. This is visible in greater emphasis on scenario work, the development of measurable safety goals and operational resilience measures. These Safety-II elements make cumulative and future risks more visible in a system where major accidents are rare. They also provide an evidence base (indicators, near-miss learning, operational insights) that goes beyond historical accident data to justify costly measures. However, crisis-driven attention can fade. When the trigger disappears from political focus, the effort to anticipate can weaken. This makes formalising Safety-II practices important (e.g., embedding scenario-based reviews, reporting and learning loops and shared indicators into routine processes) so that anticipatory capacity stays beyond temporary windows of attention.

In the United Kingdom, Safety-II is present mainly through process learning. Leasing rounds have been redesigned to resolve constraints earlier and MCA guidance and expectations are updated based on experience to avoid rework and conflict. These adaptive updates strengthen delivery and consenting efficiency, but system-wide scenario-based anticipation is less visible in the absence of a comparable major-accident trigger for offshore renewables (Chapter 7.3.1).

Comparatively, both systems adapt over time. However, in the United Kingdom learning is more oriented towards improving project delivery and the consenting pathway, where the Netherlands shows a stronger movement towards system-level anticipation as North Sea density increases. In both cases, Safety-I remains project-focused, but Safety-II shapes whether governance develops a durable basis for learning and forward-looking safety arguments as offshore wind scales. Where Safety-II depends mainly on temporary triggers, anticipatory capacity may be temporary. Institutionalisation matters because it stabilises learning and evidence production even when political attention and urgency decline (Chapter 7.3.1-7.3.5).

8.2.4. Dual-layer compliance structure

The fourth sub-question is:

How is compliance with shipping safety ensured in practice through a dual-layer structure (a prescriptive baseline plus performance-based oversight)?

Compliance with shipping safety in both cases is ensured through a dual-layer structure. The first layer provides a prescriptive baseline of non-negotiables that sets hard constraints for siting and minimum technical and procedural requirements (e.g., protecting routeing measures and port approaches, marking/lighting and construction safety procedures). The second layer is performance-based. Within the boundary conditions of the baseline, projects must demonstrate through assessment and consultation that residual risk is acceptable in the local context and that proposed mitigation is sufficient. The prescriptive layer creates stability and minimum safety demands, while the performance layer provides flexibility where rule-based prescriptions are incomplete, contested or context-dependent (Chapter 7.4).

In the Netherlands, the prescriptive baseline is stabilised relatively early through plan-led spatial allocation and state-prepared site decisions. Safety-relevant requirements are integrated upstream be-

fore tendering of the offshore wind farms, which reduces uncertainty about minimum conditions for developers. Performance-based elements then operate within this pre-set scope through the NRD/EIA evidence pipeline and site-specific requirements. They become increasingly important as multi-use ambitions and congestion make simple exclusion less feasible.

In the United Kingdom, the prescriptive baseline is expressed strongly through guidance and recurring red lines, but the performance layer carries relatively more weight after leasing. Developers produce most of the assessment and justification, and safety influence depends on the ability to provide evidence that a project is acceptable in a record that inspectors and decision-makers can rely on. This shifts practical compliance work towards the quality of documentation, the effectiveness of consultation and the capacity of authorities to examine claims and proposed mitigations.

The key difference is therefore where the prescriptive layer is translated into binding project constraints and how strongly the performance layer becomes the site of negotiation. In both cases, distance frameworks function not only as technical benchmarks but also as governance resources. They anchor debates about acceptable deviation from an established safety reference point and provide leverage in trade-off discussions (Sections 7.4.1–7.4.2).

As offshore wind scales and sea space becomes denser, the implication is that the performance layer becomes increasingly important. More situations become a trade-off and justification challenge rather than being resolved through simple avoidance rules. Dual-layer compliance remains robust only if performance-based variation from prescriptive benchmarks can be assessed and defended in a comparable and transparent way. This raises the importance of consistent methods, shared evidence bases and sufficient review capacity as cumulative interactions increase (Chapter 7.5).

Taken together, the sub-question answers show that the timing and form of safety influence depend on where alignment is stabilised, how coordination is organised and how evidence is mobilised. The next section integrates these mechanisms into a single explanation of how national governance chains shape when and how navigational safety is integrated as offshore wind scales.

8.3. Main research question: integrated answer

This section answers the main research question:

How do vertical coordination, horizontal coordination, Safety-I/Safety-II approaches and compliance design shape the integration of shipping safety into offshore wind planning in the Netherlands and the United Kingdom as offshore wind scales up?

Shipping safety is integrated into offshore wind planning in both the Netherlands and the United Kingdom through a governance chain that narrows options from upstream spatial steering to coordination and evidencing to consent conditions and operational arrangements. The central argument of this thesis is that safety outcomes are not determined by any single instrument (planning, consultation, NRA, or standards) but by how four layers align: Where vertical steering stabilises responsibilities and constraints, how horizontal coordination brings sectors together to shape choices, how the dual-layer compliance structure allocates what is non-negotiable versus what must be justified, and whether learning mechanisms (Safety-II) generate the evidence needed to govern cumulative risk as density increases.

The starting point is where alignment is stored vertically, because it determines the timing of lock-in and the distribution of responsibility across levels for defining the safety problem. In the Netherlands, national marine spatial planning and state-led site preparation translate international baselines into binding boundary conditions relatively upstream. This stabilises the safety scope early in the process. Key spatial choices and minimum requirements are set before tendering and later stages focus on implementation within those conditions. In the United Kingdom, steering is more distributed and marine planning is less central for large projects. Alignment is stabilised through leasing-stage screening and then through developer-led proof within the consenting record. This shifts more outcome-defining safety work downstream into assessment, justification and record-based decision-making on regional level.

This vertical configuration directly shapes the role of horizontal coordination. Both systems are poly-centric and rely on a mix of formal arenas and informal pre-alignment. However, timing determines whether coordination can shape spatial feasibility or only negotiate mitigation after commitments are

made. If upstream steering stabilises constraints early, horizontal coordination is more likely to operate as boundary-setting. Sector knowledge is incorporated while spatial choices are still flexible and can translate into binding conditions. If stability is achieved later through record-based consenting (as in the United Kingdom chain), coordination becomes more focused on consultation capacity and on how concerns are expressed and responded to in formal documentation. In both systems, therefore, early coordination does not remove conflict. It changes where conflict is resolved: through spatial steering upstream or through mitigation and proportionality debates downstream.

Across both cases, these coordination patterns result in evidence dependency that determines whether maritime safety influence can be converted into requirements. Even when safety is formally embedded early, decision-makers still require defensible and proportionate justification when measures compete with other policy objectives or have high costs. This is why quantified and traceable evidence functions as a governance resource in both systems. In the United Kingdom, the absence of a maritime veto makes this dependence especially visible. Influence is dependent on the robustness of recommendations and the strength of the evidence in the record during consultation and permit examination. In the Netherlands, formal co-signing power strengthens the position of safety actors at key decision points. However, restrictive or costly measures still depend on evidence that can withstand discussions and proportionality considerations. The result is that safety authority differs in form, but not in its underlying dependence on evidence: either to compensate for limited formal power (UK) or to justify impactful upstream constraints (NL).

Across both cases, the dominant operating mode remains Safety-I, seen through non-negotiable baselines and project-level demonstrations of acceptability. Therefore, Safety-II matters as an enabling capability rather than a replacement of Safety-I. It gives the insight and evidence that safety actors need to make forward-looking claims when major accidents are rare. Scenario work, indicators, near-miss learning and learning loops expand what can be justified without historical accident data and support proportionality arguments for costly measures. In the Netherlands, incidents and OVV oversight created momentum for initiatives among safety actors for such anticipatory practices, but these triggers can fade. Institutionalising Safety-II elements (routine scenario-based reviews, shared indicators and formalised learning loops) helps preserve evidence capacity beyond temporary windows of attention. In the United Kingdom, Safety-II appears more through adaptive process learning (e.g., redesigned leasing and updated guidance), improving delivery and reducing late conflict. However, it provides a weaker basis for system-wide anticipation in the absence of a comparable trigger.

These learning and evidence-producing capabilities become increasingly important because compliance in both systems operates through a dual-layer structure. A prescriptive baseline establishes non-negotiables that provide minimum requirements. This is complemented by a performance-based layer requiring project-specific proof that residual risk is acceptable under site-specific conditions. As sea space becomes denser and projects interact cumulatively, more decisions shift into this performance layer, not because standards weaken, but because situations cannot be resolved through simple avoidance. The robustness of dual-layer compliance therefore depends on whether Safety-II outputs (forward-looking evidence, comparable indicators, and shared learning) are translated into consistent assessment methods, a reliable evidence base and sufficient review capacity. This ensures that deviations from prescriptive benchmarks can be evaluated whether they are acceptable.

This integrated answer shows that safety outcomes depend on how upstream steering, coordination capacity, evidence influence and learning mechanisms align within each national planning system. The next section translates these mechanisms into practical implications for the actors who can intervene in these leverage points and formulates conditional lessons for other contexts.

8.4. Illustrative scenarios

The integrated answer above describes some of the mechanisms at an abstract level. The two short scenarios below translate this mechanism into concrete planning situations. They are not empirical case descriptions, but illustrative examples that illustrate how Safety-II evidence can convert weak signals into governance-relevant proof and how the location of alignment affects whether learning stabilises system-wide decisions or remains project-specific.

8.4.1. Anticipatory evidence under rapid scale-up

To illustrate what the integrated mechanism could mean in practice, consider a scenario in which a new offshore wind cluster is developed near a busy shipping corridor while traffic patterns at the same time increase. During early construction of the first project, a near-miss occurs in which a large vessel passes closer to the construction zone than anticipated due to weather and traffic interactions. Under a Safety-I logic alone, this event would remain an isolated deviation from the norm addressed through project-specific mitigation. Under a Safety-II logic, the event would trigger an anticipatory evidence process. Scenario testing of “surprise” combinations of factors (visibility loss, traffic peaks, tug unavailability), setting up operational indicators (e.g., close-pass frequency, deviation rates, response times) and an update of shared baselines used in NRAs. The effects on governance then depend on where alignment is stored. If alignment is stored upstream, the updated evidence can be translated into revised boundary conditions and minimum requirements for subsequent site decisions, reducing late-stage redesign and dispute. If alignment is stabilised downstream, the same evidence enters primarily through the consenting record, shifting safety influence toward project-by-project evidencing and proportionality debate under time pressure. This scenario highlights why Safety-II functions as an evidence-producing capability and why the location of alignment determines whether learning stabilises system-wide planning or remains episodic at the project level.

8.4.2. ERTV coverage as a proportionate safety requirement

Consider a debate during planning and consenting of a new offshore wind cluster about whether dedicated ERTV coverage should be required. Developers and delivery-oriented actors may contest such a requirement as costly and disproportionate, especially when major accidents in the area are rare and existing towage and Coast Guard capacity nominally exists. A Safety-II evidencing approach allows safety regulators to make the claim defensible by shifting the argument from historical accidents to interaction-driven escalation. Regulators can develop a set of plausible scenario combinations (winter storm conditions plus loss of propulsion or anchor dragging near the site, construction-phase traffic peaks and temporary towage unavailability) and connect these to operational indicators (actual response-time under relevant weather states, traffic density trends and regional disabled-vessel calls). By expressing the issue as a response-time safety envelope, showing that existing capacity fails to meet a critical threshold in specific conditions, regulators can justify adaptive and proportionate consent conditions, such as seasonal or trigger-based ERTV requirements, pooled regional coverage or monitoring-and-learning clauses that update thresholds over time.

8.5. Implications for practice and conditional lessons for other contexts

This section translates the integrated explanation from Chapter 8.3 into implications for practice. The implications are formulated as conditional lessons rather than one-size-fits-all recommendations. What is feasible and effective depends on whether safety is stabilised primarily through plan-led upstream steering (as in the Netherlands) or through more distributed, record-based negotiation downstream (as in the United Kingdom).

8.5.1. State planners and MSP authorities

What this actor controls (in the cases)

In the Netherlands, actors responsible for or influencing marine planning hold strong steering capacity through central marine spatial planning and the sequencing of wind energy areas and sites. This model allows the state to design the solution space early by applying navigational safety principles and boundary conditions in area allocation and site preparation. This reduces the likelihood that major conflicts emerge during late-stage consenting. In the United Kingdom, MSP authorities have less direct allocative control for large projects. Marine plans provide a policy reference and datasets, but key spatial steering occurs through The Crown Estate’s leasing rounds, which use upstream screening and consultee input to exclude or refine high-conflict areas. The United Kingdom case also showed that more upstream steering and more precise planning, reduces later stage conflicts or delays.

What becomes fragile under this governance type

In plan-led systems, the main fragility is that early allocation decisions must remain credible as the system changes. When space becomes denser and traffic patterns evolve, upstream avoidance alone does not guarantee an acceptable safety outcome. It becomes necessary to demonstrate that cumulative risk remains within a defensible envelope. The Dutch mini-cases show that when a prescriptive baseline is too thin (e.g., early distance rules), it can produce “paper compliance” and disputes, which undermines certainty and legitimacy. In addition, the strong marine plan steering also needs to adapt if development of turbines increase the spacing and room for vessels. One system wide plan every 6 years, risks that the system does not adapt to a rapidly changing industry.

In fragmented or non-plan-led systems, the fragility is different. Because MSP is not the leading mechanism, integration depends on the quality of screening and on the downstream ability to defend choices through the consenting record. This increases dependence on cross-authority data sharing and consultation capacity. It raises the risk that residual trade-offs become concentrated in late-stage evidence disputes once projects are commercially committed.

What capability closes the gap

Across both governance types, a key capability is building and maintaining a shared, forward-looking evidence baseline early enough to shape space allocation. In the Netherlands this means complementing central spatial steering with scenario work, traffic projections and measurable safety goals so that choices remain defensible under uncertainty and cumulative change. In the United Kingdom, it means continuing to strengthen upstream screening at leasing stage (observed in Round 5) and ensuring that marine plan datasets and consultee knowledge are integrated early enough to reduce downstream redesign and consenting risk.

8.5.2. Maritime safety authority and consenting/inspection functions

What this actor controls

In both cases, maritime safety authorities shape outcomes mainly by defining acceptable safety conditions, reviewing evidence and translating concerns into requirements that are clear to decision-makers. In the United Kingdom, the MCA is involved early and can object, but it is not the consenting authority. Its influence travels through guidance, written representations and the strength of the evidence trail in the record. In the Netherlands, maritime safety influence is structurally stronger at key decision points (e.g., through formal inter-ministerial mechanisms and co-signing). However, it must remain defensible under legal constraints and proportionality expectations. The OVV mini-case highlights that political attention and formal accountability cycles can increase or decrease the weight of safety claims by creating mandate and resources for stronger risk governance. The polycentric system also creates opportunity. Because authority is distributed across programmes and organisations, safety actors can strengthen influence by building coalitions with actors who share compatible interests (e.g., regulators concerned with enforceability, emergency-response actors, defence, or environmental authorities). In practice, coalition-building increases the chance that safety concerns become translated into conditions, because they are no longer based on just safety claims.

What becomes difficult or fragile under this governance type

A central fragility in the United Kingdom is that “no veto” produces an evidence-politics dynamic. Safety claims are only as influential as the ability to translate them in a way that inspectors and ministers can rely on when balancing competing policy objectives. This makes uneven data quality, variable NRA practice and limited quantifying capacity critical vulnerabilities. However, the Dutch case indicates that formal gatekeeping does not eliminate the need for evidence either. Even with stronger power, objections must be reasoned, proportionate and defensible. As a result, quantified parameters strengthen influence in both systems. Either to compensate for limited formal power (UK) or to support the justification of restrictive or costly measures (NL).

What capability closes the gap

Two capabilities stand out. First, regulators need the ability to assess and challenge developer-led proof and to maintain consistency across projects. The United Kingdom case shows iterative learning through updated guidance and earlier engagement, but also highlights the need (e.g., DNV) for more

integrated, system-oriented risk documentation for offshore renewables. This also requires safety-relevant information to circulate beyond safety authorities alone. Interview evidence suggests that non-safety regulators also want visibility into ongoing safety management. This indicates that effective governance depends on continuous communication across the wider network. In practice, this helps other actors understand the implications for their own responsibilities, align earlier in the process and respond more effectively to concerns.

Second, anticipatory evidence production. Safety-II practices (scenario work, indicators, near-miss learning) provide a way to make cumulative and future risks visible and to justify claims when major accidents are rare. The Dutch OVV-report shift illustrates how such evidence can become a governance resource that strengthens safety actors' position in trade-offs and supports investment in capability.

A practical implication is not to replace existing analytic assessments, but to complement them with systemic approaches that explicitly examine interaction risks, control responsibilities and feedback loops. Riemersma et al. [45] conclude that appropriate risk assessment in increasingly complex systems involves both analytic and systemic methods and highlight the importance of studying how safety is organised during rapid development.

8.5.3. Lessons for other countries

The two cases show how offshore wind and maritime safety governance seem to evolve as scale increases and space becomes congested. Across both systems, shipping safety becomes more important over time, early integration becomes more valuable and solely project-by-project proof becomes less sufficient as cumulative interactions and future uncertainty grow. In the Netherlands, permit-first dynamics produced overlap and conflict. This led to a shift toward more plan-led spatial planning and earlier safety integration. In the United Kingdom, the main adaptation has been to move steering upstream through leasing and area screening. They combined this with iterative learning and updating of guidelines and practice based on experience. This move toward upstream spatial steering is not unique to the Dutch case. Germany's EEZ maritime spatial planning also coordinates uses such as shipping and offshore wind through spatial area designations [7]. It is complemented by ongoing reporting/monitoring of spatially relevant developments, showing how plan-led approaches are maintained and updated as sea-space pressures increase.

These observations translate into conditional lessons for countries at earlier stages of offshore wind development:

- First, countries that rely heavily on developer-led siting and permitting may face increasing overlap, multi-use conflicts and low predictability as project volumes grow. Sweden provides another example of these early-stage issues, with increasing debate about cumulative and cross-sector conflicts under project-by-project development [54]. The Dutch case suggests that system-wide spatial designation and clearer upstream boundary safety conditions can reduce late disputes and improve consistency. They did need to ensure that the spatial strategy remained legally defensible and was continuously updated as density increases and evidence quality improves.
- Second, countries that depend primarily on project-level proof may expose developers to costly late-stage redesign, delay or refusal. Especially when cumulative effects are not addressed until the consenting stage. The United Kingdom case indicates that stronger upstream screening, earlier engagement with key consultees and clearer evidence expectations (through informal pre-meetings) can reduce downstream consenting risk. However, this only works if regulators have sufficient capacity and if shared databases enable consistent assessments.
- Third, both cases suggest the value of analysing the system resilience before major accidents happen. As offshore wind scales, Safety-II elements function more as an evidence-producing capability. Scenario work, performance indicators and near-miss learning help make future risks visible and support justification of measures that cannot be defended through historical accidents alone. Anticipatory evidence production is not an extra, but it is a way to justify safety claims and prioritise operational measures under uncertainty and rare high-consequence events.

Overall, the cases do not imply that Dutch or United Kingdom governance is categorically better than that of countries at earlier stages of offshore wind development. They offer insight into how safety can

be prioritised without stopping development, where typical fragilities show up as the system scales and which capabilities are needed to avoid waiting for serious accidents before governance reacts.

8.5.4. Next steps for decision-makers

Based on the cross-case findings, the following actions would directly strengthen navigational safety governance as offshore wind scales:

- Institutionalise anticipatory safety evidence production (MSP authorities and maritime safety actors): Embed routine scenario-based reviews near-miss learning and structured learning loops in planning cycles so that Safety-II capacity persists even when incident-driven attention fades.
- Strengthen upstream screening where it has the highest impact (state planners / leasing bodies): Use early engagement with shipping and other users to exclude or refine high-conflict areas before commercial and procedural lock-in increases.
- Invest in review capacity and consistency (regulators/inspectors): Ensure necessary expertise and resources to challenge (developer-led) assessments and to assess deviations from prescriptive benchmarks transparently and consistently.
- Maintain and update a shared evidence base (MSP authorities and sector partners): Set up shared datasets and operational parameters (routes, manoeuvring needs, port practices, traffic projections) so cumulative interactions can be assessed with comparable inputs across projects and departments.

8.5.5. Transferability to other sectors

An implication of this thesis is that the proposed analytical lens is not limited to maritime safety or offshore wind. The way the governance arrangements and mechanisms condition the production and use of evidence and thereby the safety integration is transferable to other sectors where safety is negotiated in polycentric, multi-actor systems under rapid transition and uncertainty.

A first relevant domain is future gas systems. Here, safety is shaped by interacting technical changes and fragmented institutional responsibilities. In such systems, Safety-II can be understood not only as a mindset but as an evidence-producing capability. Scenario work, monitoring, weak-signal detection and learning practices help make emerging and cumulative risks governable when historical accidents provide limited insights. This aligns with research arguing that future gas infrastructures require stronger alignment between technological developments and institutional coordination to sustain robust safety management under transition.

A second example is electricity grid expansion and system integration, with rapid reinforcement of distribution networks, new offshore grids and increased coupling with renewables and flexible demand. Similar to offshore wind, safety and reliability outcomes are strongly influenced by how evidence travels across planning, consenting and operational arenas. Modelling assumptions, operational constraints, incident/near-miss learning, and performance indicators must be translated into credible justifications for design choices and permits.

What changes across sectors are primarily the actors and regulatory instruments, the type of risks and the evidence base that is considered credible. However, the underlying governance challenge remains comparable. Safety outcomes depend on whether evidence can travel across decision arenas and whether feedback from operations is translated into timely updates of rules, responsibilities and design choices. As such, the framework offers a structured way to compare sectors and to identify where safety integration is constrained by misaligned responsibilities, insufficient evidencing production or weak learning loops under rapid developments.

8.6. Discussion

8.6.1. What this thesis adds to the literature

The thesis contributes to four literature streams that are often discussed separately: multi-level governance, polycentric governance, Safety-I/Safety-II and regulatory/compliance design. However, it shows that they are tightly coupled in the real governance process. The main contribution is therefore an interaction of the four. It explains how vertical alignment can strengthen offshore wind planning for

regulators and developers, while outcomes still depend on how polycentric actor interactions are coordinated and on whether the safety mode and compliance design produce the evidence and leverage safety actors need.

Revised framework derived from the case comparison

Figure 8.1 presents the revised conceptual framework derived from comparison. The original model linked vertical and horizontal coordination to two safety mechanisms and then to “observed safety performance”. The case comparison showed that this final step bundled together two analytically different elements. First, the production of evidence (e.g., risk assessments and monitoring) and second the integration outcomes (e.g., boundary conditions, safety distances, access rules, and ETV requirements). It also did not show how operational experience feeds back into subsequent planning rounds.

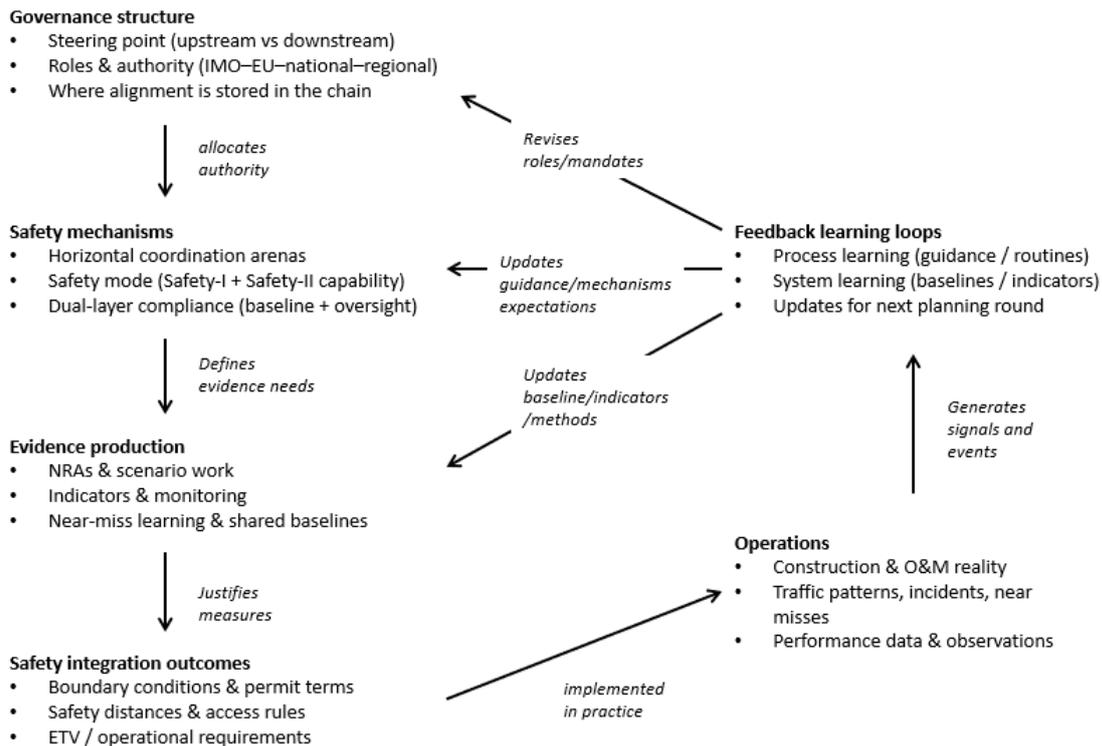


Figure 8.1: Revised conceptual model linking governance mechanisms and safety paradigms

Governance structure shapes the safety mechanisms through which safety is operationalised. These mechanisms define what counts as credible evidence and how evidence is produced. Evidence then supports, legitimises and constrains safety integration outcomes. Importantly, outcomes are implemented in practice and generate operational signals (performance data, incidents, near misses) that feed back into learning loops. These feedback loops can update baselines, indicators and methods, but can also revise guidance and role expectations in later planning and consenting rounds.

Two empirical insights are central in this revision. First, in polycentric governance settings, evidence is not just descriptive but a governance resource. It determines whether safety concerns can be translated into defensible requirements under uncertainty and proportionality constraints. The second important insight is not only whether alignment exists, but where alignment is stored in the governance process. This location systematically shifts when conflicts emerge, which actors carry the evidencing burden and how dependent the system becomes on coordination capacity and recurring learning practices.

The revised framework gives a map of the thesis contribution and structures the discussion below. The discussion details how multi-level steering, polycentric coordination, safety mode and compliance

design together shape evidencing capacity and the sustainability of safety integration over time.

Interaction contribution: how the four layers reinforce or undermine each other

Building on the revised framework in Figure 8.1, the main contribution of this thesis is to show how the four dimensions interact to shape offshore-wind shipping safety governance. Vertical steering can strengthen planning by storing alignment upstream and embedding shipping safety, but outcomes still depend on whether polycentric coordination translates concerns into decisions. Polycentric governance becomes manageable when coordination mechanisms bring actors together early and when the safety mode produces defensible evidence under uncertainty. When coordination capacity and the safety mode align, safety actors can translate concerns into enforceable requirements and trade-offs. Where they misalign, through fragmented programmes and weak evidence, safety influence shifts toward project-by-project evidence and system-wide anticipation becomes weak.

Rather than treating these dimensions as independent, the case comparison shows that these layers can reinforce each other (e.g., upstream steering + recurring arenas + anticipatory evidence + enforceable conditions) or undermine each other (e.g., fragmented programmes + bounded project evidence + late-stage lock-in). The following subsections explain each layer and then return to their combined effect on safety integration over time.

Multi-level governance: how vertical alignment is operationalised through planning instruments

Multi-level governance research shows that policy outcomes in complex systems are shaped by interaction across governance levels rather than by a single hierarchical decision-maker. In the revised framework, this dimension is captured in the governance structure layer, which determines how international baselines are translated into national planning instruments and where key safety constraints are stabilised.

The empirical findings show how this works in offshore-wind shipping safety. International regimes (IMO/SOLAS and IALA) set a binding baseline for what states can do in the EEZ. At national level, these constraints are translated into planning instruments, project requirements and consent conditions. In both countries, this happens through national area designation and through regulations or guidelines that turn higher-level constraints into project-level requirements.

The main conceptual insight is that vertical alignment should not be understood simply as a matter of more or less alignment. What matters is also where alignment is stored in the governance chain. Where it is stored upstream, through plan-led designation, shipping safety is embedded earlier and the risk of late-stage conflict is reduced. It depends more on the quality and legitimacy of early allocation decisions. Where it is stored downstream, through evidence-led consenting, the system remains more flexible, but also becomes more vulnerable to late lock-in, uneven evidence quality, and case-by-case conflict resolution.

This refines the multi-level governance literature by showing that not only the presence of vertical alignment matters, but also the point in the governance chain at which it is stabilised. That location shapes how much later stages depend on polycentric coordination and defensible evidence to secure safety outcomes and avoid late-stage disputes.

Polycentric governance: how influence works through power, timing, and evidence

Polycentric governance literature emphasises that multiple centres of authority can improve robustness through redundancy, checks and balances and learning. In the revised framework, this dimension is primarily captured in the safety mechanisms layer through horizontal coordination. It determines whether actors are effectively working together early enough and whether their interaction produces the evidence needed to translate safety concerns into decisions.

The empirical findings nuance the polycentric literature by showing that a polycentric system can function either as a system of checks and balances (NL) or as an integration challenge (UK). It depends on whether coupling mechanisms exist that bring actors together repeatedly and at the right moments. Across both cases, influence is not primarily exercised through formal hierarchical control. Instead, it is

produced through three channels. First, the coordination capacity who can convene and sustain interaction early enough to shape options before commitments are made. Second, timing whether safety concerns are raised before commercial and procedural lock-in reduces the feasible solution space. Third, the evidence leverage whether claims are supported by defensible, measurable and transferable evidence that can travel across decision arenas. In politically sensitive moments, a fourth channel becomes visible. Political attention, which can elevate or remove safety and coexistence issues on the agenda and thereby increase the weight of particular actors and accelerate cross-sector alignment.

This matters theoretically because it shifts the focus from who has authority to how authority becomes effective. Even where formal gatekeeping exists, actors are constrained by reasonableness and proportionality expectations. Influence often depends on whether concerns can be justified in terms that other actors and decision-makers accept. In the revised framework, quantified evidence is therefore not simply an analytical input but a governance resource. It turns concerns into defensible requirements rather than preferences. Where formal veto is absent, this evidence becomes even more central because safety requirements are stabilised through the consenting record and must withstand examination by decision-makers.

Overall, the findings specify a concrete mechanism for polycentric outcomes in infrastructure siting. Influence is produced through timely coordination and evidence-based justification under time pressure. This implies that the effectiveness of polycentric governance depends on whether coordination arenas and evidencing production are sufficiently developed to translate competing claims into binding safety integration outcomes and whether feedback learning loops can stabilise these outcomes across following project cycles.

Safety-I and Safety-II: coexistence, but with different functions in permitting systems

The Safety-I/Safety-II literature is often framed as a shift from one paradigm to another. The findings of this thesis suggest a different interpretation for offshore wind governance. The logics coexist and have different functions. In the revised framework, this is captured in the safety mechanisms layer, which shapes what counts as credible evidence and how safety can be justified in decisions. Safety-I remains dominant in day-to-day regulation because it fits legal accountability. It operationalises safety into minimum requirements and project-level risk acceptability. Safety-II enters less as a replacement and more as an additional capability focused on anticipation and learning.

Conceptually, this thesis extends Safety-II to planning and permitting contexts by highlighting an additional function besides resilience and learning: legitimisation under uncertainty. In these settings, Safety-II operates as an evidence-producing capability. Scenario work, weak-signal detection, near-miss learning and cumulative-risk analysis help make future and interaction risks visible when major accidents are rare and historical accident data is not a sufficient basis. This aligns with arguments that Safety-I is effective when past performance is informative, whereas Safety-II is better suited to complex systems where safety concerns emerge from interactions and must be understood through everyday performance and adaptive learning [44].

The empirical contribution is to show how this evidence function becomes central to governance in polycentric permitting systems. Quantified and traceable outputs (e.g., scenario analyses, indicators and near-miss-based learning) increase the leverage of safety actors in trade-off debates by translating anticipatory concerns into defensible requirements. In the revised framework, this clarifies why Safety-II gains practical influence only when its outputs are absorbed by the coordination and compliance set-up. They must be credible under political and evidentiary scrutiny and usable for enforceable conditions. Where this absorption capacity is weak, Safety-II remains episodic or programme-based, while Safety-I continues to dominate through baseline compliance and project-by-project risk demonstrations.

Dual-layer compliance: why performance-based governance grows as density and multi-use increase

The regulatory and compliance literature differentiates prescriptive, rule-based approaches from performance-based regulation. The cases show that offshore wind shipping safety governance combines both in a dual-layer structure. In the revised framework, this sits in the safety mechanisms layer and directly influences the evidence layer. A prescriptive baseline institutionalises non-negotiable requirements

(e.g., minimum standards and hard constraints), while a performance-based layer provides flexibility by requiring project-specific proof that risk is acceptable once mitigations are applied.

The empirical contribution is that this dual-layer structure is not static. As sea space becomes denser and multi-use becomes politically relevant, simple avoidance and exclusion become less feasible. This increases reliance on performance-based demonstration to justify coexistence solutions under contested trade-offs. In practice, the performance-based layer expands because it is the main route through which developers and regulators can argue that safety is achieved when spatial compromises are unavoidable.

This connects directly to the other literature streams in the revised framework. Performance-based governance only functions in polycentric settings if it produces evidence that is credible across actors and can be translated into enforceable decisions. Dual-layer compliance therefore does not only add flexibility, it shifts which capacities become critical. Shared data collection, methodological stability and review capacity assess whether proof is comparable and defensible. It also redistributes influence toward actors who can define evidence standards and convert proof into binding consent conditions. Where these capacities are weak or fragmented, the performance-based layer becomes vulnerable to inconsistent quality and project-by-project evidence politics.

Bringing the layers together: reinforcing loops and failure modes

Taken together, the findings suggest two reinforcing configurations and one common failure mode, as summarised in the revised framework.

First, when vertical steering stores alignment upstream and is coupled to recurring coordination arenas, safety concerns can be raised early enough to avoid late-stage lock-in. In the revised framework, this strengthens the link from governance structure to safety mechanisms. Early boundary-setting creates a stable decision space in which coordination can focus on trade-offs rather than reopening fundamentals. This, in turn, creates room for Safety-II elements (scenario work, indicators, learning from near-misses) to inform decisions before commercial commitment and to feed into a more consistent evidence base.

Second, when anticipatory Safety-II evidence is translated into enforceable consent conditions within a dual-layer compliance structure, it increases the defensibility of measures under uncertainty. In the revised framework, this is a reinforcing loop between evidence and outcomes. Quantification and traceability do not only improve analysis, they stabilise influence by making future risks visible in terms that can be acted on by decision-makers.

A common failure mode occurs when programmes remain fragmented and alignment is stored late in the chain. In that setting, safety influence becomes dependent on project-by-project evidence politics and the consenting record, while system-wide anticipation and learning remain weak. This highlights that offshore-wind shipping safety governance is not determined by any single dimension, but by how steering, coordination, evidencing and compliance interact over successive planning and consenting cycles.

8.6.2. Limitations

This thesis aimed to explain how governance arrangements shape the integration of shipping safety into offshore wind planning through a comparative study of the Netherlands and the United Kingdom. The limitations below clarify what the research design can and cannot claim, and how this affects the scope of the conclusions.

Design and scope limitations

The study is based on a two-case comparative design. This enables the study to dive deep into the process and build theory through the differences between the cases. However, it also limits transferability. Other countries operate under different legal traditions, institutional histories, traffic profiles, grid connection strategies and political priorities, which may lead to different patterns. As a result, the cross-case propositions in Chapter 7 and the integrated answer in Section 8.3 should be read as mechanisms that occur in their circumstances rather than universal templates. The value of the design lies in identifying plausible explanatory mechanisms that can be tested and refined in additional cases, rather than providing statistically generalisable claims. A related scope limitation is that the analysis focuses

on planning and consenting as the primary stages where shipping safety is negotiated and stabilised. While operational governance (monitoring, incident response and day-to-day traffic management) is discussed where it directly connects back to planning choices, the research does not attempt a full operational safety evaluation.

A further contextual limitation is that offshore wind planning and political targets change over time. Changes in development pace can shift coordination intensity and the importance of safety issues (e.g., attention cycles and urgency of spatial multi-use). This means that some mechanisms described here may be stronger during rapid scale-up phases than during periods of slower development. This affects the timing and weight of the mechanisms observed, but not the underlying governance challenge of multi-use, safety integration, evidencing and coordination.

Data limitations

The empirical base consists mainly of semi-structured interviews and document analysis. A first limitation concerns interview coverage and representation bias. Access to Dutch experts was stronger due to available network, whereas getting in contact with United Kingdom experts was more difficult because of greater caution related to confidentiality. This could create an asymmetric evidence base. Dutch institutional dynamics and examples could be described in more detail, while United Kingdom process insights rely on fewer perspectives and more public documentation. The implication for this thesis is that absence of data in the United Kingdom case cannot be interpreted as evidence of absence of certain dynamics or mechanisms. On subjects where the analysis describes practices as less visible or less institutionalised in the United Kingdom, this should be read as a possible difference, and claims are therefore framed as indicators and supported by document analysis where possible.

A second limitation concerns document availability and observability. Planning and consenting systems produce extensive documentation, but availability is selective and uneven across stages and institutions. In addition, public records primarily capture what becomes formalised in consultation and consent decisions. They reveal less about informal negotiation, internal risk debate and operational practices. As a result, the thesis provides stronger insight into how safety is integrated and justified within the permitting chain than into how safety performs in practice once projects operate over time.

Relatedly, code frequencies are indicative and should not be interpreted as quantitative measures of importance or causal weight. A code may appear often because it is easier to discuss in interviews, while rare or complex themes may still be critical. The analysis therefore relies on triangulation and pattern consistency rather than frequency alone.

8.6.3. Future research

The limitations of this thesis show several directions for future research. In particular, the two-case design and the national scope limit transferability. The focus on planning and consenting provides less insight into cross-border interactions and long-term operational performance. Building on these limitations, three future research areas stand out.

First, to address the largely national scope of this study, future research should investigate cross-boundary alignment of shipping-safety governance as offshore wind farms move closer to borders. This thesis shows that safety outcomes depend strongly on how safety is integrated in the governance process and on how evidence travels across decision arenas. Future research could therefore examine how neighbouring states align (or fail to align) spatial boundary conditions, routing assumptions, navigational risk methodologies and emergency-response arrangements for offshore wind near borders. Particular value would come from studying whether shared mitigation measures, such as joint monitoring or coordinated emergency towing coverage are feasible in existing governance set-ups and which coordination mechanisms reduce operational gaps between countries.

Second, to address the limited insight into operational governance and the time-variance of safety attention, future research could research how Safety-II can be institutionalised as a recurring capability in offshore wind governance, instead of appearing mainly through programme initiatives or incident-driven attention. A finding of this thesis is that Safety-II elements can function as an evidence-producing capacity. Scenario work, indicators and near-miss learning make cumulative and future risks visible and help justify measures when major accidents are rare. Yet the cases provide limited insight into the

frequency, ownership and governance integration of these practices over time. Future research could compare designs for recurring safety analysis (e.g., periodic scenario reviews, mandatory near-miss reporting or performance-indicator dashboards). It could assess when such arrangements strengthen future-proof decision-making, reduce late-stage redesign and increase the defensibility of safety claims.

Finally, to address the reliance on interview and document evidence and that code frequencies are indicative rather than measures of weight, future research could build a comparison of evidencing practices across projects. The thesis highlights that the influence of maritime safety actors depends on translating concerns into quantified evidence that decision-makers can rely on. NRAs and underlying baselines can vary across consultants, projects and jurisdictions. Future research could therefore systematically compare NRAs across projects and countries to identify variation in assumptions, modelling choices and data quality. It could test how different standardisation strategies (e.g., shared baselines, minimum methodological requirements or independent review capacity) affect consenting outcomes and the durability of safety requirements over time.

8.7. Personal reflection

Besides the findings, this thesis was also a learning process in doing research in a complex multi-actor setting. The most difficult part was defining the problem and capturing it in a concrete research question. During the first month of the internship I came across new developments and new issues almost daily, which made the topic feel like it changes or got bigger every day. I stayed too broad for too long and only gradually learned to structure what the governance and safety system consisted of and what a feasible and interesting analytical focus could be.

A key lesson was how to build structure under complexity. Bringing together multiple concepts was not only a theoretical choice, but almost a necessity to make sense of a diverse problem. I also learned to translate abstract safety ideas into observable elements in the cases (e.g., roles, decision points, mechanisms and the types of evidence that are included in the process).

Finally, similar to offshore wind planning, this thesis project involved multiple stakeholders across different organisations. I learned that keeping supervisors and colleagues involved in the project requires proactive communication, by sharing interim findings early, making assumptions and choices explicit and creating moments for feedback.

If I were to do this project again, I would set a clear time limit for the exploratory phase more strictly and commit earlier to a working research question and scope, even when knowing it might need refinement later. I would also sketch an initial version of the conceptual model in the first weeks and use it as a tool to guide data collection and to prevent scope expansion during the project.

References

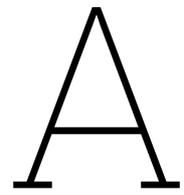
- [1] Government of Alberta. *Environmental Tools: Performance-Based Standards*. Tech. rep. Accessed: 2025-11-13. Edmonton, Alberta, Canada: Environment and Parks, Government of Alberta, 2019. URL: https://www.alberta.ca/system/files/custom_downloaded_images/ep-environmental-tools-performance-based-standards.pdf.
- [2] European Court of Auditors. *Special Report 03/2023: Internal electricity market integration*. Special Report 03/2023. Audit of the internal electricity market under the Energy Union strategy. European Court of Auditors, 2023. URL: https://www.eca.europa.eu/lists/ecadocuments/sr23_03/sr_energy_union_en.pdf.
- [3] William Jesse Baltutis and Michele-Lee Moore. “Degrees of change toward polycentric transboundary water governance: exploring the Columbia River and the Lesotho Highlands Water Project”. In: *Ecology and Society* 24.2 (2019), p. 6. DOI: 10.5751/ES-10852-240206.
- [4] Shubharthi Barua, Xiaodan Gao, and M.S. Mannan. “Comparison of prescriptive and performance-based regulatory regimes in the U.S.A and the U.K.” In: *Journal of Loss Prevention in the Process Industries* 44 (2016), pp. 764–769. DOI: 10.1016/j.jlp.2016.10.009.
- [5] Bjørn-Morten Batalden and Are Kristoffer Sydnes. “Maritime safety and the ISM code: a study of investigated casualties and incidents”. In: *WMU Journal of Maritime Affairs* 13.1 (2014), pp. 3–25. DOI: 10.1007/s13437-013-0051-8. URL: <https://link.springer.com/article/10.1007/s13437-013-0051-8>.
- [6] Juliane Biehl, Johann Köppel, and Marie Grimm. “Creating space for wind energy in a polycentric governance setting”. In: *Renewable and Sustainable Energy Reviews* 152 (2021), p. 111672. DOI: 10.1016/j.rser.2021.111672.
- [7] Bundesamt für Seeschifffahrt und Hydrographie (BSH). *Maritime Spatial Planning*. https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/maritime_spatial_planning_node.html. Accessed 2026-01-26.
- [8] Keith Carlisle and Rebecca L. Gruby. “Polycentric Systems of Governance: A Theoretical Model for the Commons”. In: *Policy Studies Journal* 47.4 (2017). Open access under CC BY-NC-ND 4.0, pp. 927–952. DOI: 10.1111/psj.12212.
- [9] Committee on the Effectiveness of Safety and Environmental Management Systems for Outer Continental Shelf Oil and Gas Operations. *Evaluating the Effectiveness of Offshore Safety and Environmental Management Systems*. Special Report 309. Washington, D.C.: Transportation Research Board of the National Academies, 2012. URL: <https://onlinepubs.trb.org/onlinepubs/sr/sr309.pdf>.
- [10] Department for Energy Security and Net Zero (UK). *Offshore Wind Net Zero Investment Roadmap*. Tech. rep. Accessed: Saturday 7th March, 2026. London, UK: Government of the United Kingdom, Mar. 2023. URL: <https://www.gov.uk/government/publications/offshore-wind-net-zero-investment-roadmap/offshore-wind-net-zero-investment-roadmap>.
- [11] David Dimelow. *Offshore Renewables Risk Management: A Pragmatic Safety Case*. White paper. © DNV 08/2025. DNV, Aug. 2025.
- [12] A. Durakovic. *Vattenfall Shows Damage Caused by Cargo Ship Adrift at Hollandse Kust Zuid Offshore Wind Farm | Offshore Wind*. 2022. URL: <https://www.offshorewind.biz/2022/02/02/vattenfall-shows-damage-caused-by-cargo-ship-adrift-at-hollandse-kust-zuid-offshore-wind-farm/> (visited on 02/02/2022).
- [13] Federal Aviation Administration. *Out Front on Airline Safety: Two Decades of Continuous Evolution*. <https://www.faa.gov/newsroom/out-front-airline-safety-two-decades-continuous-evolution>. Accessed: 2025-11-13. Aug. 2018.

- [14] Government.NI. *Ostend Declaration on the North Sea as Europe's Green Power Plant | Diplomatic Statement*. 2023. URL: <https://www.government.nl/documents/diplomatic-statements/2023/04/24/ostend-declaration-on-the-north-sea-as-europes-green-power-plant> (visited on 04/24/2023).
- [15] Päivi Haapasaari et al. "A proactive approach for maritime safety policy making for the Gulf of Finland: Seeking best practices". In: *Marine Policy* 60 (2015), pp. 107–118. ISSN: 0308-597X. DOI: 10.1016/j.marpol.2015.06.010. URL: <https://www.sciencedirect.com/science/article/pii/S0308597X15001621>.
- [16] Peter M. Haas. "Introduction: Epistemic Communities and International Policy Coordination". In: *International Organization* 46.1 (1992), pp. 1–35. DOI: 10.1017/S0020818300001442. URL: <https://www-jstor-org.tudelft.idm.oclc.org/stable/2706951?seq=22>.
- [17] Hisham Saadawi. "Process Safety Thirty Years After Piper Alpha Disaster". In: *Journal of Petroleum Technology (JPT)* (June 2018). Accessed: Saturday 7th March, 2026. URL: <https://jpt.spe.org/process-safety-thirty-years-after-piper-alpha-disaster>.
- [18] HM Coastguard. *Our locations*. URL: <https://hmcoastguard.uk/locations> (visited on 01/06/2026).
- [19] Erik Hollnagel, Robert L. Wears, and Jeffrey Braithwaite. *From Safety-I to Safety-II: A White Paper*. White paper. Published in association with the University of Southern Denmark, University of Florida, and Macquarie University. The Resilient Health Care Net, 2015. URL: <https://www.england.nhs.uk/signuptosafety/wp-content/uploads/sites/16/2015/10/safety-1-safety-2-whte-papr.pdf>.
- [20] Liesbet Hooghe and Gary Marks. "Unraveling the Central State, but How? Types of Multi-level Governance". In: *American Political Science Review* 97.2 (2003), pp. 233–243. DOI: 10.1017/S0003055403000649. URL: <https://doi.org/10.1017/S0003055403000649>.
- [21] House of Commons Transport Committee. *National Policy Statement for Ports*. Fourth Report of Session 2024–26 HC 1028. Ordered to be printed 11 November 2025. House of Commons, Nov. 14, 2025. URL: <https://publications.parliament.uk/pa/cm5901/cmselect/cmtrans/1028/report.html> (visited on 01/21/2026).
- [22] Florian Kern et al. "Empowering sustainable niches: Comparing UK and Dutch offshore wind developments". In: *Technological Forecasting & Social Change* 100.1 (2015), pp. 344–355. URL: <http://dx.doi.org/10.1016/j.techfore.2015.08.004>.
- [23] Ercan Kivanç, Gülfem Tuzkaya, and Özalp Vayvay. "Safety management system and risk-based approach in aviation maintenance: A systematic literature review". In: *Safety Science* 184 (2025), p. 106755. DOI: 10.1016/j.ssci.2024.106755.
- [24] Maaïke Knol-Kauffman, Ann-Magnhild Solås, and Peter Arbo. "Government-industry dynamics in the development of offshore waste management in Norway: from prescriptive to risk-based regulation". In: *Journal of Environmental Planning and Management* 64.4 (Mar. 2021), pp. 649–670. DOI: 10.1080/09640568.2020.1779676.
- [25] Anders Larsen et al. "Independent Regulatory Authorities in European Electricity Markets". In: *Energy Policy* 34.17 (2006), pp. 2858–2870. DOI: 10.1016/j.enpol.2005.05.003.
- [26] Sander Lokhorst and Gea Kolk. *Breedte doorvaart-passages. Windparken op de Noordzee*. X23-GPK-HS-RAP-22007883. Versie 1.0; Status: Vrijgegeven; Proj.nr. MN004105. Movares, Dec. 2022.
- [27] Timothe Macquart, Duygu Kucukbahar, and Bob Prinsen. *Offshore Wind Market Report*. Tech. rep. Retrieved: 2025-11-26. Utrecht, The Netherlands: Netherlands Enterprise Agency (RVO), May 2023. URL: <https://www.rvo.nl/sites/default/files/2023-05/Offshore-Wind-Market-Report.pdf>.
- [28] Maritime and Coastguard Agency. *Marine Guidance Note MGN 372 (M+F): Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs*. Marine Guidance Note MGN 372 (M+F). File ref: MNA/053/010/0626. Crown Copyright 2008. Maritime and Coastguard Agency, Aug. 2008. URL: https://assets.publishing.service.gov.uk/media/5fc6505fd3bf7f7f575b4365/MGN_372.pdf (visited on 01/21/2026).

- [29] Maritime and Coastguard Agency. *Offshore Renewable Energy Installations (OREIs): Guidance on UK Navigational Practice, Safety and Emergency Response Issues*. MGN 371 (M+F). Published August 2008. © Crown Copyright 2008. Maritime and Coastguard Agency, Aug. 2008.
- [30] Maritime and Coastguard Agency. *Offshore renewable energy installations: impact on shipping*. First published 21 September 2012; last updated 16 January 2024. Jan. 16, 2024. URL: <https://www.gov.uk/guidance/offshore-renewable-energy-installations-impact-on-shipping> (visited on 01/06/2026).
- [31] Maritime and Coastguard Agency. *Safety of Navigation: Offshore Renewable Energy Installations (OREIs) — Guidance on UK Navigational Practice, Safety and Emergency Response*. MGN 654 (M+F). Marine Guidance Note. Crown Copyright. Maritime and Coastguard Agency, Apr. 2021.
- [32] Ministerie van Economische Zaken en Klimaat. *Ontwerpkavelbesluit VII windenergiegebied Hollandse Kust (west): herzien ontwerp*. Dutch. Ontwerpkavelbesluit. Den Haag: Ministerie van Economische Zaken en Klimaat, Sept. 2021. URL: <https://www.rvo.nl/sites/default/files/2021/09/Herzien-Ontwerpkavelbesluit-VII-Wind-op-zee-Hollandse-Kust-west.pdf> (visited on 12/09/2025).
- [33] Ministerie van Infrastructuur en Waterstaat. *Policy advice on Offshore Wind Energy Shipping Safety: Working together now towards a safe North Sea*. Ministerie van Infrastructuur en Waterstaat, June 2025.
- [34] Ministerie van Infrastructuur en Waterstaat. *Programma Noordzee 2022–2027*. Dutch. Beleidsprogramma. Den Haag: Ministerie van Infrastructuur en Waterstaat, Mar. 2022. URL: <https://www.rvo.nl/files/file/2022-05/Programma-Noordzee-2022-2027-VAWOZ-2030.pdf>? (visited on 12/09/2025).
- [35] Amir Mohammad Moghani and Reyhaneh Loni. “Review on energy governance and demand security in oil-rich countries”. In: *Energy Strategy Reviews* 57 (2025). DOI: 10.1016/j.esr.2024.101625. URL: <https://doi.org/10.1016/j.esr.2024.101625>.
- [36] MSc Complex Systems Engineering and Management. *MSc Complex Systems Engineering and Management*. n.d. URL: <https://www.tudelft.nl/onderwijs/opleidingen/masters/cosem/msc-complex-systems-engineering-and-management> (visited on 10/01/2025).
- [37] Nautilus International. *UK must put safety before cost in emergency towing cover*. Telegraph section. Sept. 24, 2020. URL: <https://www.nautilusint.org/en/news-insight/telegraph/uk-must-put-safety-before-cost-in-emergency-towing-cover/> (visited on 01/06/2026).
- [38] Jens Newig and Oliver Fritsch. “Environmental Governance: Participatory, Multi-Level – and Effective?” In: *Environmental Policy and Governance* 19 (2009), pp. 197–214. DOI: 10.1002/eet.509. URL: <https://onlinelibrary.wiley.com/doi/pdf/10.1002/eet.509>.
- [39] Noordzeeloket. *ERTV. Emergency Response Towing Vessels op de Noordzee*. Dutch. Informatiepagina over inzet van Emergency Response Towing Vessels (ERTV’s) voor scheepvaartveiligheid rond windparken op zee. 2024. URL: <https://noordzeeloket.nl/functies-gebruik/energietransitie-zee/windenergie-zee/scheepvaartveiligheid-moswoz/ertv/> (visited on 12/09/2025).
- [40] Fiona Nunan. “Navigating multi-level natural resource governance: An analytical guide”. In: *Natural Resources Forum* 42 (2018), pp. 159–171. DOI: 10.1111/1477-8947.12149. URL: <https://doi.org/10.1111/1477-8947.12149>.
- [41] Björn Nykvist, Sara Borgström, and Emily Boyd. “Assessing the adaptive capacity of multi-level water governance: ecosystem services under climate change in Mälardalen region, Sweden”. In: *Regional Environmental Change* 17 (2017), pp. 2359–2371. DOI: 10.1007/s10113-017-1149-x.
- [42] Vincent Ostrom. *Polycentricity and Local Public Economies: Readings from the Workshop in Political Theory and Policy Analysis*. Ed. by Michael D. McGinnis. Includes chapters by Vincent Ostrom, Elinor Ostrom, and others. Ann Arbor: University of Michigan Press, 1999. URL: https://www.press.umich.edu/11836/polycentricity_and_local_public_economies.

- [43] L. Prinzel et al. "The Adaptable and Resilient Safety System: The Human Factor in Future In-Time Aviation Safety Management Systems". In: *Proceedings of the AIAA/IEEE Digital Avionics Systems Conference (DASC)*. NASA Langley Research Center, NASA Ames Research Center, Crown Consulting Inc., Flight Research Aerospace, San Jose State University Foundation. Hampton, VA / Moffett Field, CA / Aurora, CO, 2023.
- [44] Ben Riemersma, Aad F. Correljé, and Rolf W. Künneke. "Incorporating Safety-II in future gas systems". In: *Safety Science* 173 (2024), p. 106462. DOI: 10.1016/j.ssci.2024.106462.
- [45] Ben Riemersma et al. "Upholding Safety in Future Energy Systems: The Need for Systemic Risk Assessment". In: *Energies* 13.24 (2020), p. 6523. DOI: 10.3390/en13246523. URL: <https://www.mdpi.com/1996-1073/13/24/6523>.
- [46] Rijksdienst voor Ondernemend Nederland. *Wet- en regelgeving medegebruik in windparken op de Noordzee*. Dutch. Projectnummer 122038 (Maripark); Versie 1; auteurs: Maartje Smit (Witteveen+Bos) en Inge Widdershoven (RVO). Rijksdienst voor Ondernemend Nederland, July 2025. URL: <https://kennisdelen.rvo.nl/file/download/09598dc2-9d0c-4f41-bcd5-527601b52498/rvo-rapport-wet-en-regelgeving-medegebruik-in-windparken-op-de-noordzee.pdf> (visited on 01/06/2026).
- [47] Rijkswaterstaat. *Doorvaart en medegebruik*. Ministerie van Infrastructuur en Waterstaat. Noordzeeloket. URL: <https://noordzeeloket.nl/functies-gebruik/energietransitie-zee/windenergie-zee/doorvaart-medegebruik/> (visited on 01/06/2026).
- [48] Rijkswaterstaat. *Juridisch beleidskader*. Noordzeeloket (Ministerie van Infrastructuur en Waterstaat). URL: <https://noordzeeloket.nl/beleid/beleidskaders/juridisch/> (visited on 01/14/2026).
- [49] Rijkswaterstaat. *Rijkswaterstaat breidt dienstverlening met AIS-scheepvaartdata uit naar Noordzee*. Nieuwsbericht (Ministerie van Infrastructuur en Waterstaat). Noordzeeloket. URL: <https://noordzeeloket.nl/functies-gebruik/energietransitie-zee/windenergie-zee/data-inwinning-noordzee/nieuwsberichten/rijkswaterstaat-breidt-dienstverlening-ais/> (visited on 01/06/2026).
- [50] Rijkswaterstaat. *Vessel Traffic Monitoring*. Scheepvaartveiligheid (MOSWOZ). Ministerie van Infrastructuur en Waterstaat. Noordzeeloket. URL: <https://noordzeeloket.nl/functies-gebruik/energietransitie-zee/windenergie-zee/scheepvaartveiligheid-moswoz/vessel-traffic-monitoring/> (visited on 01/06/2026).
- [51] Schipperen met ruimte. *Beheersing van scheepvaartveiligheid op een steeds vollere Noordzee*. 2024. URL: <http://www.onderzoeksraad.nl> (visited on 2024).
- [52] R. C. Spijkerboer et al. "Unravelling institutional work patterns: Planning offshore wind farms in contested space". In: *Environmental Innovation and Societal Transitions* 40 (2021), pp. 249–261. DOI: 10.1016/j.eist.2021.08.002.
- [53] M. Sujan et al. "What kinds of insights do Safety-I and Safety-II approaches provide? A critical reflection on the use of SHERPA and FRAM in healthcare". In: *Safety Science* 173 (2024), p. 106450. DOI: 10.1016/j.ssci.2024.106450.
- [54] Swedish Agency for Marine and Water Management and Swedish Energy Agency. *Coexistence of offshore wind power with commercial fishing, aquaculture and nature conservation: A synthesis of knowledge about preconditions and measures*. Tech. rep. 2023:7. Gothenburg, Sweden: Swedish Agency for Marine, Water Management, and Swedish Energy Agency, Aug. 2023.
- [55] Systems Engineering Technology. *UK EEZ Shipping Risks and Emergency Towage Provision Study*. FNC 63552/50217R. Issue No. 1. Prepared for the Maritime and Coastguard Agency (MCA). Maritime and Coastguard Agency, Apr. 2020. URL: https://assets.publishing.service.gov.uk/media/5f4e57ebd3bf7f0a2d41c503/S_31_-_ANNEX_A_-_Summary_Report.pdf (visited on 01/06/2026).
- [56] The Crown Estate. *Celtic Sea Floating Offshore Wind Leasing Round 5: Site Selection Methodology*. Report. Final Site Selection Methodology (version history notes a draft in July 2022). The Crown Estate, Dec. 2023. URL: https://downloads.ctfassets.net/nv65su7t80y5/20XMBM3YE VQPDKvpRQpkHC/965956e2515fcf98f24c138af6ddba98/Site_Selection_Methodology_V2.pdf (visited on 01/21/2026).

- [57] The Crown Estate. *FLOWW. The Fishing Liaison with Offshore Wind and Wet Renewables Group*. URL: <https://www.thecrownestate.co.uk/our-business/marine/the-fishing-liaison-with-offshore-wind-and-wet-renewables-group> (visited on 01/04/2026).
- [58] The Crown Estate. *Offshore Wind Leasing Round 4: Summary Stakeholder Feedback Report*. 38255-TCE-REP-025. Version 1.2 (Final). The Crown Estate, Sept. 2019.
- [59] The Planning Inspectorate. *Scoping Opinion: Proposed North Falls Offshore Wind Farm*. Case Reference: EN010119 (EN010119-000054). Aug. 2021. URL: <https://nsip-documents.planninginspectorate.gov.uk/published-documents/EN010119-000054-EN010119%20-%20Scoping%20Opinion.pdf> (visited on 01/16/2026).
- [60] Jack Thomas. *UK offshore wind faces bottlenecks that threaten 2030 targets, says EIC*. <https://www.innovationnewsnetwork.com/uk-offshore-wind-faces-bottlenecks-that-threaten-2030-targets/61210/>. Innovation News Network. Accessed 2026-01-23. Aug. 2025.
- [61] Emma Verling et al. "Can Risk-Based Approaches benefit future Offshore Renewable Energy deployment, planning and consenting processes?" In: *Proceedings of the 15th European Wave and Tidal Energy Conference (EWTEC 2023)*. Bilbao, Spain, 2023. DOI: 10.36688/ewtec-2023-306. URL: <https://research.ucc.ie/en/publications/can-risk-based-approaches-benefit-future-offshore-renewable-energy/>.
- [62] Werkgroep 'veilige afstanden'. *Afwegingskader voor veilige afstanden tussen scheepvaartroutes en windparken op zee. Versie na vaststelling in het directeurenoverleg van 9 juli 2013*. Dutch. Adviesrapport. Ministerie van Infrastructuur en Milieu, July 9, 2013. URL: <https://noordzeeloket.nl/%40167518/afwegingskader-veilige-afstanden-tussen/> (visited on 12/09/2025).
- [63] Daniel Wiegant, Art Dewulf, and Josephine Van Zeben. "Alignment mechanisms to effectively govern the sustainable development goals". In: *World Development* 182 (2024), p. 106721. DOI: 10.1016/j.worlddev.2024.106721.
- [64] J. F. Wiegner et al. "Interdisciplinary perspectives on offshore energy system integration in the North Sea: A systematic literature review". In: *Renewable and Sustainable Energy Reviews* 189 (2024), p. 113970. DOI: 10.1016/J.RSER.2023.113970.
- [65] Daniel Zeichner. *UK reaches agreement on North Sea fishing opportunities for 2025*. <https://www.gov.uk/government/news/uk-reaches-agreement-on-north-sea-fishing-opportunities-for-2025>. Retrieved: 2025-11-26. Dec. 2024.



Cross-case mapping table

Aspect	Netherlands (NL)	United Kingdom (UK)
Upstream steering & earliest safety entry	State-led marine spatial planning and area designation (North Sea Programme) + sequencing via roadmap; navigational safety embedded early through plan-level boundary conditions (avoidance of main traffic, spacing/routeing principles)	Leasing-led spatial steering via The Crown Estate screening and leasing rounds; navigational safety enters early through screening and consultee input (MCA); marine plans mainly provide policy input
Main lock-in point	Plan-level designation is the strongest avoidance lock-in; later lock-in occurs when NRD/EIA translate into draft <i>kavelbesluit</i> conditions	Commercial lock-in increases after bidding/lease award; procedural lock-in occurs at formal submission and examination; optimisation happens within awarded lease boundaries
Project-level siting/consent decision	<i>Kavelbesluit</i> (site decision) developed via NRD scoping + EIA/MER evidence; co-signing by other ministries is required	Developer-led design + EIA and NRA feed into statutory consent route (NSIP examination for >50 MW); licence conditions negotiated through consultation
Burden of proof	The state commissions/organises much of the evidence base for the site decision; developers enter later with predefined conditions	Developer initiates scoping and produces the project evidence base (incl. NRA); authorities respond through consultation and demands
Role of maritime authority in consent	Maritime safety concerns are formally resolved before final site decision; co-signing structure creates a clear influence	MCA is a consultee (not the consenting authority); influence depends on defensible evidence and recommendations in the consent record ('no veto')
Main safety evidence product	NRD (scope) + EIA/MER studies supporting the site decision	NRA alongside EIA documentation; written representations and recommended conditions feed examination
Where alignment is happening (upstream vs downstream)	Alignment is realised relatively upstream through marine planning and binding site decision conditions, reducing late-stage conflicts but increasing reliance on the quality of early allocation	Alignment is achieved relatively downstream through evidence-led consenting and examination, preserving flexibility but increasing risks of late-stage conflicts and uneven evidence quality
Primary coordination mechanism in polycentric setting	Recurring central coordination arenas and inter-departmental meetings support early alignment and issue escalation before late-stage objections	Coordination relies more on consultation capacity and planning across parallel programmes; integration depends on the effectiveness of screening, consultation and examination
Shared baselines/data (coordination resource)	More state-prepared baselines and central processes reduce dependence on project-by-project baseline disputes (though evidence must remain defensible)	Shared baselines and consistent assumptions become critical; disagreements over traffic data or modelling assumptions can become institutional disagreement, increasing the importance of data-sharing and methodology
Trigger and attention cycle for system-wide safety	Incidents plus OVV oversight can raise political attention and unlock mandate/resources for more anticipatory approaches (scenario work, verifiable goals)	No equivalent defining trigger in offshore renewables; learning is more incremental via leasing and guidance updates, while system-wide anticipation remains comparatively thinner

Table A.1: Summary: governance chain characteristics relevant to navigational safety

B

Informed Consent Form

Dear [name],

You are being invited to participate in a research study titled "Integrating safety into the governance of offshore wind energy". This study is being done by Jelmer Merkus from the TU Delft and The Ministry of Infrastructure & Water Management.

The purpose of this research study is to research how safety is or could be integrated in the governance of offshore wind energy and will take you approximately 60 minutes to complete. The interview will be recorded and transcribed for analysis. We will be asking you to answer questions about the policy measures taken to mitigate shipping safety risks in and around offshore windfarms and the process of making those policies.

Any confidential information and transcripts will be removed from the final product, but needs be accessed by the graduation committee.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by storing the personal data collected on TUD institutional storage, accessible only to the TUD research team. This data will be deleted immediately after the end of this project.

The insights gathered during the interview will be presented in an anonymous and aggregated form in scientific publications and presentations.

The data will be deleted at latest one month after completing the project. (expected date: March 2026).

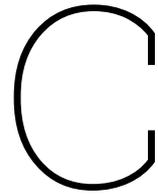
Your participation in this study is entirely voluntary **and you can withdraw at any time**. You are free to omit any questions. Any data can be removed from the project, within a week after the interview.

Contact details researcher:

Jelmer Merkus
j.merkus@student.tudelft.nl
Aad Correlje
a.f.correlje@tudelft.nl

	Yes	No
I agree that my responses, views or other input can be quoted anonymously in research outputs	<input type="checkbox"/>	<input type="checkbox"/>
Permission to audio-record the interview	<input type="checkbox"/>	<input type="checkbox"/>
Permission to use anonymous quotes in publications	<input type="checkbox"/>	<input type="checkbox"/>
Permission to store data securely	<input type="checkbox"/>	<input type="checkbox"/>
I would like to receive the interview transcript to review and approve before analysis and publication.	<input type="checkbox"/>	<input type="checkbox"/>

Signatures I have read and understood the study information above, and I se		
_____	_____	_____
Name of participant [printed]	Signature	Date



Interview guide: Offshore wind planning

C.1. Opening and position

1. Can you briefly describe your role within Climate & Green Growth / MMO with regard to offshore wind?
2. What part of the offshore wind planning process are you mainly involved in?
3. Can you briefly outline how a site decision is made, and at what times shipping safety is explicitly considered?

C.2. Coordination mechanisms: where do interests converge?

1. What formal coordination mechanisms currently exist in which interests around offshore wind come together?(*e.g., Coast Guard, North Sea Consultation, interdepartmental working groups, MSP processes, seabed leasing*)
2. What role does KGG/MMO play in these consultations in relation to:
 - I&W (Transport Department)
 - EZ (Economic Affairs)
 - Defence
 - RWS / Coast Guard
 - Ports and shipping companies
3. To what extent do you think these consultations are:
 - substantive guidance,
 - coordinating,
 - or mainly consultative?
4. Which formal coordination mechanisms are actually used to make decisions?
5. In which phases of the roadmap and site decision processes do you yourself have a seat at the table (area exploration, EIA, site decision, tender)?

C.3. Weighing interests in practice

1. Can you give a concrete example in which the interests of energy development, shipping safety and/or defence had to be weighed up with each other in the case of offshore wind?

2. Documents mention allowing vessels < 24 meters in wind farms under AIS conditions. As far as you know, how did those rules come about? How were fishing interests and safety weighed up in that process?
3. The rules include an AIS obligation and fixed corridors. Were these hard preconditions from the Ministry of Infrastructure and Water Management / shipping safety, or did they arise during the site decision process in consultation with fisheries and recreation?
4. What role did your management have in including rules on vessels < 24 metres and AIS in the site decisions?
5. How does such a consideration work in practice?
 - Is there a fixed methodology?
 - Or is this case-dependent?
6. In practice, do you see that certain interests often outweigh others?
 - Can you explain that?
 - Is shipping safety seen as a precondition, negotiable interest, or free-rider?

C.4. Timing of shipping safety

1. At what point in the offshore wind process is shipping safety actively taken into account?
 - Designation of plots?
 - EIA phase?
 - Licensing?
 - Or only upon realisation?
2. Who formally introduces shipping safety?
 - I&W itself?
 - RWS / Coast Guard?
 - External advice (TNO, MARIN)?
3. How is the input from the Ministry of Infrastructure and Water Management / RWS / the Coast Guard translated into the text and regulations of a site decision? Who ultimately “draws the pen” there?
4. To what extent does safety still influence spatial choices, such as:
 - location of plots,
 - corridor formation,
 - safety zones?
5. At what point in the offshore wind process is shipping safety actively taken into account, and where in that process does the site decision play a role?
6. Are there examples where safety was taken into account too late to really steer?
7. In MOSWOZ and in the EIAs, risks are often modelled at an early stage. Do these analyses really help to adjust plots, or do they mainly confirm existing choices?

C.5. Safety logic: reactive or proactive?

1. If you think about shipping safety around offshore wind in your work: is it mainly a matter of “complying with existing rules and frameworks”, or is there also room to learn and adapt things along the way?
2. How do insights or requirements from the Ministry of Infrastructure and Water Management / RWS / Coast Guard reach you in the site decision process?
 - Are these mainly fixed preconditions?

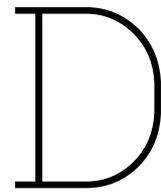
- Or are they also still being discussed substantively?
3. Can you give an example where new insights or advice (e.g., MOSWOZ, OvV, I&W) have led to an adjustment of a site decision, regulations or layout?
 - Or does this mainly happen in practice with subsequent plots?
 4. To what extent does the rapid upscaling of offshore wind put pressure on the time and space you have in the site decision process to properly work out safety aspects?
 - How is safety usually experienced in the site decision process: tolerating factor, necessary precondition, or legitimisation of choices?
 5. Have there been situations where the pace of offshore wind has led to suboptimal safety solutions?

C.6. Vertical influence: European and international frameworks

1. The North Sea Programme states that the Ministry of Infrastructure and Water Management is responsible for the integration of shipping safety into wind planning. How do you view this division of roles from KGG? Where does this affect your work on plot decisions?
2. What role do international frameworks (IMO, IALA, EU directives) play in Dutch choices regarding offshore wind?
3. Where is the Netherlands mainly:
 - following international frameworks?
 - and where is the Netherlands leading the way?
4. Do you see tensions between international harmonisation and national spatial ambitions?

C.7. Reflection and future

1. Where do you see the biggest governance challenge for shipping safety in the further scaling up of offshore wind?
2. What do you think should be different in:
 - coordination mechanisms?
 - timing of safety?
 - roles and responsibilities?
3. If you could change one thing in the current system, what would it be?



Interview guide: shipping safety

These questions are intended to understand how maritime safety in the Netherlands is ensured during the planning and operation of offshore wind projects. The focus is on governance, coordination and how security concerns are integrated within and between organisations

D.1. Role and responsibilities

1. Can you describe your current role within the maritime department of IenW?
2. How does your role relate to the shipping safety of offshore wind development and maritime shipping?
3. Can you describe the role of the I&W in the planning and permitting process for offshore wind projects? In which phases do you get involved?

D.2. Governance and decision-making

1. Which other organisations are most involved in shipping safety around offshore wind areas (e.g. Rijkswaterstaat, Coast Guard, ILT, Ministry of Economic Affairs and Climate, ports)?
2. How are the responsibilities divided between I&W and these organisations, and where do overlaps arise?
3. When a safety concern is expressed, how is this converted from discussion to a concrete decision?
4. Is this often by means of advice, measure or demand?
5. How does the Ministry of Infrastructure and Water Management weigh up maritime safety against other policy goals, such as targets for renewable energy or spatial efficiency at sea?

D.3. Coordination and integration

1. What formal consultation structures or coordination mechanisms are used to achieve coordination between ministries and sectors (e.g. shipping, energy, nature, defence)?
2. Which of these mechanisms do you find most effective in resolving potential conflicts between shipping and offshore wind?
3. To what extent are stakeholders such as the shipping sector or offshore developers involved in shaping safety decisions?
4. Can you give examples?
5. How are trade-offs made in practice when plans for offshore wind energy conflict with maritime or safety interests?
6. Are prioritization rules used, or are they looked at on a case-by-case basis?

7. Are the different sectors negotiating from an equal position?
8. Whose point of view is usually dominant when there are disagreements or a decision has to be made? For example, when using ERTVs or safety distances?

D.4. Safety approach and regulations

1. Would you describe the current approach to maritime safety as more compliance-rule-driven (Safety-I) or more goal-oriented/learning-oriented (Safety-II)? Why?
2. How are lessons learned from incidents or near-incidents at sea used for learning?
3. How is this translated into new regulations, guidelines or procedures?
4. Where do you mainly use prescriptive safety rules (e.g. fixed distances, traffic separation systems) and where is there room for more performance-oriented approaches?
5. Which factors determine whether I&W chooses one or the other?

D.5. Spatial planning and cumulative risk

1. How does I&W ensure that safety is integrated early in the marine spatial planning process for offshore wind?
2. Who is responsible for assessing cumulative risks of multiple wind farms and changing shipping routes?
3. How does I&W coordinate with Rijkswaterstaat and the Coast Guard to monitor and manage these risks in practice?
4. Do you think the rapid expansion of offshore wind energy puts pressure on safety, or are the safety measures and processes robust enough to withstand it?

D.6. International and future-oriented outlook

1. How do international rules (IMO, IALA, EU directives) influence national decisions on maritime safety in relation to offshore wind?
2. Do you actively participate in international organizations or working groups? Do you have any examples?
3. Are there areas in which international guidelines are still missing or unclear for offshore wind contexts?
4. Would more international regulation or cooperation better integrate safety into the governance of wind farms?
5. On which themes would this be desirable?
6. Looking ahead, what changes would you like to see in the Dutch governance process to integrate security more proactively and efficiently?
7. Is there anything that you think is often misunderstood about the role of I&W in maritime safety for offshore wind?

E

Coding table and coding tree

Code	Operational definition (what to code here)	Freq. (NL/UK/T)
PM — Process Mechanisms		
PM_Process phase / stage	References to phases/stages of the process and when/where safety is addressed across the process timeline.	50/17/67
PM_Tools & methods used	Mentions of methods/tools used to structure decisions (e.g., assessments, modelling, guidance, procedures, templates).	48/16/64
PM_Decision criteria used	Statements about decision criteria/thresholds, prioritisation logic, or what counts as a “good/acceptable” outcome.	34/17/51
PM_Traceability & documentation	Mentions of documentation, audit trails, reporting, transparency, and recording the rationale behind decisions.	24/4/28
PM_Stage-gates / point-of-no-return	References to milestones, formal decision gates, lock-in moments, and moments when reversing choices becomes difficult.	22/5/27
PM_Bottlenecks & delays	Mentions of slowdowns, bottlenecks, procedural delays, or capacity constraints in the process.	16/2/18
HC — Horizontal coordination		
HC_Formal coordination arenas	References to formal coordination structures (committees, working groups, consultations, formal meetings, mandated coordination).	35/21/56
HC_Informal coordination arenas	References to informal coordination (ad hoc calls, personal networks, informal alignment outside formal fora).	13/3/16
HC_Conflict & contestation	Disagreement, resistance, disputes, tensions, appeals, or contestation between actors over decisions and outcomes.	22/7/29
HC_Trade-off negotiation	Negotiating compromises and package deals (explicit bargaining between actors about trade-offs).	19/8/27
HC_Actor influence – structural	Influence through formal power (legal mandate, resources, authority, statutory roles, gatekeeping positions).	20/7/27
HC_Actor influence – relational	Influence through relationships (trust, persuasion, coalition-building, reputation, informal leverage).	11/2/13

Code	Operational definition (what to code here)	Freq. (NL/UK/T)
HC_Shared language / boundary objects	Alignment through shared terms, templates, models, reports, or concepts that help actors coordinate and negotiate meaning.	5/6/11
HC_Marginalisation / dominance	Situations where some actors/values are sidelined; dominance of one actor's framing or priorities.	4/0/4
MS — Mode Safety (evidence, uncertainty, risk concepts)		
MS_Evidence basis	What is treated as evidence (data sources, expert judgement, precedents) and how evidence is mobilised to justify decisions.	33/12/45
MS_Uncertainty handling	How uncertainty is acknowledged/managed (assumptions, sensitivity, precaution, "unknowns", confidence/robustness).	27/7/34
MS_Risk acceptance / residual risk	References to what risk remains, what is acceptable/tolerable, and how residual risk is justified.	7/7/14
MS_Risk assessment scope	How boundaries of assessment are set (what is included/excluded; spatial/temporal scope; scenarios; stakeholders considered).	7/4/11
MS_Evidence politics	Contestation/strategic use of evidence (whose evidence counts, disputes over methods, politicisation of expertise).	7/2/9
MS_Safety-I framing	Safety understood as preventing things going wrong (hazard reduction, compliance, barriers, incident prevention).	9/4/13
MS_Safety-II framing	Safety understood as ensuring things go right (resilience, adaptation, capacity to respond, operational flexibility).	12/5/17
MS_Safety concept ambiguity	Explicit ambiguity/disagreement about what "safety" means, which safety metrics matter, or how safety should be operationalised.	8/0/8
VC — Vertical coordination (roles, mandates, cross-border, interpretation)		
VC_Role clarity & accountability	Clarity of responsibilities, accountability mechanisms, who is responsible for what and how responsibility is enforced.	21/22/43
VC_Mandate & delegation	Allocation/delegation of mandates (who has authority to decide, delegated tasks, remit boundaries).	5/11/16
VC_Upward/downward feedback	Feedback loops across levels (local–national–international), escalation, reporting back, iterative alignment between tiers.	6/4/10
VC_Regulatory stability vs change	Stability of regulatory expectations vs evolving rules, revisions, and changes in standards over time.	22/10/32
VC_Interpretation space / ambiguity	Discretion/interpretation in applying rules, guidance, or standards; ambiguity in implementation requirements.	11/11/22
VC_Cross-border coordination	Cross-border alignment (neighbouring states, international bodies) and practical coordination across jurisdictions.	13/3/16
VC_International translation	Translation of international guidance/standards into national practice (or vice versa); adapting practices across contexts.	11/16/27
VC_Consistency across cases	References to consistency/standardisation across projects/cases (or lack thereof); harmonisation between assessments/decisions.	4/5/9
DL — Dual Layer)		

Code	Operational definition (what to code here)	Freq. (NL/UK/T)
DL_Prescriptive requirements	Fixed, rule-based requirements (minimum standards, mandated measures, “must” requirements, hard design prescriptions).	23/18/41
DL_Performance oversight	Monitoring, inspection, enforcement, performance checks, assurance, and oversight of compliance/operations.	11/6/17
DL_Learning cycles	Iterative learning and updating over time (reviews, lessons learned, revisions after experience/incidents).	16/9/25
DL_Adaptive requirements	Flexible or adaptive requirements that can change with context, learning, or new information (iterative updating).	3/10/13
CT — Constraints & trade-offs		
CT_Political feasibility	Political acceptability, stakeholder support, reputational considerations, and what is “sellable/realistic” politically.	32/7/39
CT_Budget / who pays	Cost allocation, funding responsibilities, compensation, and affordability (“who pays for safety measures”).	28/9/37
CT_Competing public values	Balancing public values (e.g., safety, energy transition, environment, economy, spatial claims) and value conflicts.	20/16/36
CT_Legal hard constraints	Non-negotiable legal/statutory constraints, regulatory obligations, and binding legal limits.	17/5/22
CT_Technical feasibility	Practical/engineering/operational feasibility limits; implementability and technical constraints of measures.	13/7/20
CT_Capacity vs safety	Explicit trade-off between maritime capacity/efficiency and safety (throughput vs safety margins).	6/7/13
CT_Conditionality (shipping as boundary condition)	Shipping treated as a boundary condition/constraint for OWF siting and design; “shipping cannot move” framing.	10/5/15
META — Meta-references		
META_Example / case reference	Using examples, analogies, precedent cases, or specific projects/incidents to justify a position or illustrate reasoning.	27/9/36

Table E.1: Codebook from Atlas.ti coding with definitions and indicative frequency by case.; multiple codes may be applied to the same quote.

• **Not assigned to a code group (6)**

- CT_Conditionality (shipping as boundary condition)
- CT_Natura2000 constraint
- META_Example / case reference
- MS_Final boss (verifiable safety goal)
- TEMP_security
- VC_Cross-border coordination

F

Transcriptions

This appendix is confidential and not for publication.