Ref. Ares(2024)4460971 - 20/06/2024

DELIVERABLE 6.4

MANUSCRIPT OF SYNTHESIS OF RISK GOVERNANCE

Work Package 6

Legal, policy and governance

December 31st, 2023

Funded by the European Union (H2020 Grant Agreement no 862915).Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them

Grant Agreement number	**862915**
Project title	**UNITED: multi-Use platforms and co-locatioN pilots boostIng cost-effecTive, and Eco-friendly and sustainable proDuction in marine environments**
Deliverable title	Manuscript of Synthesis of Risk Governance
Deliverable number	6.4
Deliverable version	Original Submission
Contractual date of delivery	December 31st, 2023
Actual date of delivery	December 31st, 2023
Document status	Final
Document version	Version 2.0
Revision Submission	June 2024
Online access	Yes
Diffusion	Public
Nature of deliverable	Report
Work Package	WP 6 – Legal, Policy and Governance
Partner responsible	UGent
Contributing Partners	UGent, WR, SDU,
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Abstract	As ocean space increasingly is used for production purposes, such as food and feed production, renewable energy production and resource mining, competition for space becomes a concern. A spatial solution to this is to co-locate

	activities in a multi-use setting. Next to the direct (financial) costs and benefits of multi-use and the societal cost and benefits, there are other factors, in the realm of legal aspects, insurance, health and safety issues and the overall governance of multi-use, that determine whether multi-use can be implemented successfully. This includes transaction costs that arise when for example less adequate regulation, governance and insurance schemes are in place. Based on the analysis of five case studies across Europe these combined/collective transaction costs of multi-use are analysed and suggestions how to reduce and/or overcome these transaction costs are presented.
Keywords	Marine multi-use, transaction costs, governance
Change Log	Resubmission 1 – change in cover page and introduction tables

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ABREVIATIONS

AIS	ship Automatic Identification System
EIA	Environmental Impact Assessment
ICZM	Integrated Coastal Zone Management
MSP	Marine Spatial Planning
OWF	Offshore Wind Farm
ROV	Remotely Operated underwater Vehicle
SDG	Sustainable Development Goals

EXECUTIVE SUMMARY

From Task 6.2[1] and 6.3[2] a wealth of insights and plans for addressing the case-specific legal, insurance, risk and governance aspects of multi-use was derived. In this deliverable, these experiences have been brought together and were used to draw more generic conclusions on how multi-use initiatives can be facilitated. The focus of the deliverable is how transaction costs affect the legal, insurance, risk and governance aspects in multi-use. The result is a risk governance analysis manuscript founded on the experiences of the individual pilots (as in deliverable D6.4).

As ocean space is increasingly used for production purposes, such as food and feed production, renewable energy production and resource mining, available space is becoming scarce. A spatial solution to this is to co-locate activities in a multi-use setting. Next to the direct (financial) costs of multi-use and the societal cost and benefits, there are other factors, in the realm of legal aspects, insurance, health and safety issues and the overall governance of multi-use, that determine whether multi-use can be implemented successfully. Based on the analysis of five case pilots across Europe these combined/collective transaction costs of multi-use are analysed. Subsequently, the document presents suggestions on how to reduce and/or overcome these transaction costs.

Multi-use projects at sea in Europe currently face significantly higher transaction costs than single-use projects, as the actors involved have to familiarise themselves with the new risks and opportunities arising from combined uses. A crucial aspect of the minimisation of the transition costs is the reduction of the high uncertainty in this sector. We have seen that a good risk analysis done at an early stage of the project allows for the identification of the main hazards the company may face and enables the timely undertaking of mitigation actions.

These mitigation actions can minimise certain risks and lower the likelihood of incurring additional costs not considered. An important issue is the involvement of all stakeholders. Their active participation in decision-making processes enables the identification of common objectives adapted to the needs of the local community so that multi-use project enjoys wider social acceptance. It is also important to establish a dialogue with government authorities that can facilitate the creation of targeted policies for this type of business. The exchange of data and information on the experiences of businesses in training can speed up this process, and lead to the creation of a network of actors, users and companies that can trigger co-creation of knowledge and practices useful for the affirmation of the industry.

[1] 6.1 - Inventory of legal and insurance aspects, risks and risk management options and the wider governance context of risk management

[2] 6.2 - Case specific report on legal aspects and insurance issues

1. INTRODUCTION

Human use of marine space is currently rapidly increasing (Billing et al., 2022; Ramos et al., 2022; Stancheva et al., 2022; van Hoof et al., 2020). Especially the rapid development of offshore renewable energy (Demmer et al., 2022) increases the competition for ocean space with other forms of production such as aquaculture, fisheries, tourism, shipping and nature conservation (van den Burg, Röckmann, et al., 2020; van Hoof et al., 2020). The single-use paradigm, allocating space to a single use, especially in the near shore area, results in competition between uses for reasons of distance between the production site and mainland, or for physical conditions such as current and wave height, seek to be as close to shore as possible. To counter the spatial competition, ways are sought to introduce forms of co-use and multi-use of marine space and facilities (Bocci et al., 2019). With multi-use at sea, we refer to the situation where a combination of different industries and technologies use ocean space, as a joint use of resources in the same area (Ramos et al., 2022; Schultz-Zehden et al., 2018).

Multi-use at sea remains relatively new in the European context. Until recently, individual commercial operators have chosen to operate independently as the risks and costs of multi-use were perceived to outweigh the benefits (Röckmann et al., 2017; van Hoof et al., 2020). The EU-funded UNITED project (multi-Use platforms and co-locatioN pilots boostIng cost-effecTive, and Ecofriendly and sustainable proDuction in marine environments) aims to demonstrate the benefits and challenges of multi-use of marine space. The project builds on the experiences gained in five pilot projects in which economic activities, such as renewable energy production, aquaculture and tourism, are combined (UNITED, 2023).

From pilot experiences, it becomes clear that there are quite some obstacles in the path of arriving at profitable multi-use. Obstacles, in the form of legal aspects, insurance, risk and uncertainty, and the overall governance of multi-use, determine whether multi-use can be implemented successfully and be financially viable. To analyse these factors which hinder the further development of multi-use, we use the concept of transaction costs as defined in Alchian & Woodward (1988):"Costs incurred in making contracts enforceable by law or by self-enforcement, and extends to the precautions against potential expropriation (...)" and in Cheung (1969):"Included in the general term contracting cost are the costs of negotiating and the costs of enforcing the stipulations of the contract." (D. Allen, 1991). The successful implementation of multi-use depends not only on the costs and benefits for each individual economic activities but also depends on societal costs and benefits (Boyd & Heitz, 2016; Collins, 2003; Kaplow, 1986). In addition, investment decisions are also influenced by transaction costs: the total costs of making a transaction, including e.g. the costs of planning, deciding, changing plans, obtaining permits and licenses, resolving disputes and the costs of writing and enforcing contracts (Cheung, 1969).

The lack of understanding of the transaction costs of multi-use at sea is currently an obstacle to further development, this leads to the key research question of this deliverable. **Which transaction costs affect the successful development of multi-use at sea?** And, **what can be done to overcome these transaction costs?** To address this question, three facets are analysed to establish the current position faced by (potential) multi-use projects and potential ways to facilitate safe and sustainable scale-up by reducing transaction costs. These three facets consist of levels of risk and uncertainty and approaches to mitigation; the governance framework; and the insurance landscape.

This deliverable consists of 6 chapters. In chapter 2 the concept of costs and transaction costs is further discussed. In chapter 3 the five pilots of the UNITED project are introduced and the methodology of analysis is described. In chapter 4 the experiences of the five pilots are presented in terms of legal aspects, risk and uncertainty, governance aspects and insurance issues. In chapter 5 the findings are discussed and possible ways to reduce multi-use transaction costs are examined. In chapter 6 conclusions are drawn on the implications for the development of multi-use at sea.

2. THE COSTS OF MULTI-USE

In the last decades, the offshore wind energy sector developed from an embryonic to mature sector. From an investment perspective, this implies that early stage investors and government support make way for investors that are more concerned about financial returns (Jansen et al., 2020). For project opportunities, businesses, funders, and financiers each consider a large range of factors when deciding whether to invest. These include the upfront capital investment cost, the potential net operating surplus that could be achieved, the legal and policy governance framework, and the risks of proceeding (Jaldell, 2023; Sun et al., 2022). Combined, these factors determine whether the project is an investable proposition and whether commercial operators would be willing to proceed with the proposal based on commercial interests.

In addition to private impacts, some societal costs and benefits fall on parties beyond the commercial transaction. These include both positive and negative impacts on residents and the environment, as well as other ecological (Alves et al., 2019; Cisneros-Montemayor et al., 2021; Mishan & Quah, 2020) and social impacts, such as project acceptability and community needs (Billing et al., 2022; Buck et al., 2017). Societal impacts should be considered when designing an efficient legal and policy governance framework within which the project will be delivered.

There is also a public interest in this development. Especially for the development of entirely new endeavours, such as multi-use at sea, the initial private costs of investment in innovation and development are higher than the direct benefits. As the perceived societal benefits of these embryonic project opportunities are desired. the public sector can take up a role in co-financing such innovation and development (Mazzucato & Semieniuk, 2018; Schupp et al., 2019; Thiele & Gerber, 2017; van den Burg, Schupp, et al., 2020).

This is also relevant in the context of the development of multi-use at sea. In addition to the costs of capital and labour inputs required, such as steel, concrete, nets, and so forth, the total costs of delivering a project include transaction costs which fall on both public and private parties. These costs include the cost of planning and designing proposals, reviewing and deciding whether to proceed, refining proposals, resolving disputes, writing and enforcing contracts, financing, risk contingencies, and insuring assets at sea (Alaoui & Penta, 2022; N. J. Allen & Meyer, 1990; Cheung, 1969). Transaction costs incurred can be in cash or labour terms. These costs are often underestimated, which can lead to design, financial and operational problems in project realisation (Krause, 2014).

Table 1 below presents how transaction costs fit within the private and societal costs faced by prospective multi-use projects at sea based on research findings.

Table 1 – Summarising private, societal, public and transaction costs

Category	Cost types
Private costs and benefits	• Capital investment costs • Potential net operating surplus • Risks of proceeding
Societal costs and benefits	• Impacts on residents • Impacts on environment • Wider societal impacts
Public costs	• Investment in Research and Development • Financial stimulation of Innovation • Planning • Infrastructure • Management and Enforcement costs
Private and social transaction costs	• Costs of planning and designing proposals • Reviewing and deciding whether to proceed • Refining proposals • Resolving disputes

	• Writing and enforcing contracts • Risk contingencies and insurance

Hence, for any single operator, the go or no-go decision for a commercial project hinge on the analysis of the costs and benefits of that project. Next to these private costs and benefits, there may be societal costs and benefits. For example, for the decision to construct offshore renewable energy production, the private costs and benefits may be not favourable, yet the societal benefits of renewable energy production and reduced climate impact may warrant a public investment, or subsidy, to safeguard the private investment. Along similar lines, multi-use operations will have associated public and private costs and benefits. As noted elsewhere (Kyvelou & Ierapetritis, 2020; Przedrzymirska et al., 2021; van den Burg, Röckmann, et al., 2020; van den Burg, Schupp, et al., 2020; van Hoof et al., 2020) moving from single-use to multi-use brings along additional requirements in the realm of legal aspects, insurance, health and safety issues and the overall governance of multi-use. An additional effort required to obtain for example licenses and insurance may induce additional transaction costs to multi-use.

All these argumentations lead to the key research questions of this deliverable:

- Which transaction costs affect the successful development of multi-use at sea?
- What can be done to overcome these transaction costs?

3. METHODOLOGY

To identify the transaction costs associated with multi-use activities, this study is built on data collected by the UNITED project. Five pilot cases were involved in the project and this work stem from their experience and the data collected over the period 2020-2023. The first pilot is located off the North Sea coast of Germany and combines offshore wind farm (OWF) research with the cultivation of blue mussels and seaweed. The second pilot is located in Belgium waters and integrates OWF with the cultivation of European flat oysters and seaweed, and the restoration of oyster reefs. The Dutch pilot combines OWF with floating solar panel energy production, seaweed cultivation and testing of remote monitoring facilities. The Danish pilot combines OWF and tourism through organised visits to the wind turbines. The Greek pilot combines aquaculture (fish farm) and leisure scuba diving. The first three pilots are to a degree quite similar as they combine OWF with food production, while the last two pilots focus more on tourism. The variety of pilots provides the basis for a more generic analysis on the nature of transaction costs for multi-use (Figure 1).

The conclusions drawn are based on a thorough analysis of the literature as well as input from pilot participants and stakeholders who were interviewed and consulted. By combining these sources of information, the study presents comprehensive insights into the challenges and potential solutions related to transition costs in the context of multi-use projects. The data used for the analysis were collected during the UNITED project lifespan from different sources:

- literature review on multi-use;
- national and international legislation;
- interviews with operators of the pilot projects;
- questionnaire on multi-use possibilities and barriers;
- workshops with practitioners, experts and policymakers.

The literature review focused on outlining the status of multi-use in the literature, covering the 2017-2021 period. The first step was the search for all scientific literature from existing European projects related to multi-use such as MUSES[3], MARIBE[4], MERMAID[5] and SOMOS[6]. Furthermore, a SCOPUS literature search was conducted to find additional articles, resulting in 279 articles being extracted. The final review included 41 articles highlighting the opportunities, challenges and main barriers which can lead to additional costs of multi-use. The results of the literature review were used to develop a questionnaire which were sent to all pilots to explore possibilities and barriers for multi-use. The questionnaire is part of deliverable 1.1 (UNITED, 2020a).

[3] MUSES (Multi-Use in European Seas) project is a Horizon 2020 funded project that is exploring the opportunities for Multi-Use in European Seas across five EU sea basins (Baltic Sea, North Sea, Mediterranean Sea, Black Sea and Eastern Atlantic), completed in 2018 https://muses-project.com/

[4] MARIBE (Marine Investment for the Blue Economy) is a Horizon 2020 project that aims to unlock the potential of multi-use of space in the offshore economy, completed in 2016 https://maritime-spatial-planning.ec.europa.eu/projects/marine-investment-blue-economy

[5] MERMAID (Innovative Multi-purpose off-shore platforms: planning, Design and operation) develops concepts for next generation of offshore platforms for multi-use of ocean space for energy extraction, aquaculture and platform related transport, completed in 2015 https://cordis.europa.eu/project/id/288710/reporting

[6] SOMOS (Technical Standards for Safe Production of Food and Feed from marine plants and Safe Use of Ocean Space) focuses on renewable energy production in combination with seaweed, used not only food but also feed, bio-chemicals, energy and other valuable products, completed in 2018 https://www.wur.nl/en/project/somos.htm

Figure 1 – Location of the UNITED pilots. Source: UNITED project design

A comprehensive mapping of the main legislation in both national and international contexts pertaining to multi-use has been conducted to understand the legal frameworks, regulations, and policies that currently govern multi-use activities. The aim of mapping process was to explore the existing legislation seeking possibilities and gaps for multi-use. A preliminary inventory of legal and insurance issues was gathered from deliverables 1.1 and 1.2 of the UNITED project (2020a, 2020b). These results showed some of the gaps concerning transaction costs of multi-use activities. In order to focus more on potential outstanding issues of the pilots, a list of questions was made to help the pilots and their stakeholders reflect on the legal and insurance issues in their multi-use project, within a broader marine spatial planning and governance context.

Due to restraints imposed by COVID-19, all pilots were consulted during in-depth individual online interviews. The consultations complemented the questionnaire results, as pilot leads and stakeholders were expressly invited to bring in any other additional legal or insurance topic, they thought was not already covered in the documents they received. In addition, the participants were invited to provide supplementary comments after the consultations via email. The results of those consultations, together with the risk identification, assessment and mitigation of multi-use, based on the framework described by van Hoof et al. (2020) and applied to the pilots, are reported in deliverable 6.1 (UNITED, 2021). The next step focussed on the main multi-use challenges for the pilots: country-specific legal and governance issues, bottlenecks for aquaculture, opportunities and pitfalls for nature conservation, pilot-specific insurance policies and full multi-use integration. A draft report 6.2 (UNITED, 2023) was written in cooperation with the pilot leads and afterwards discussed during a full-day workshop on Legal, Insurance and Eco-restoration issues in Ghent on 22 November 2022. Almost all pilot representatives attended in person, while one pilot and some partners were present online. The discussion resulted in a workshop report. The results of the 2022 workshop were presented and discussed at the UNITED General Assembly on 6 February 2023 in Malaga. Comments at this meeting have been taken into account. A revised draft of D6.2 was once again submitted to the pilot leads and partners in April 2023 for final approval of the text. The draft text was finalised on the 12th of June 2023.

Information on hazards and risk management for the Dutch pilot was gathered during a workshop on 9 November 2021. A further workshop was held involving all pilots on 26 January 2022, the main objective being to obtain an overall picture of the hazards and risks of marine activities. The workshops were structured around the SOMOS framework. The SOMOS framework was used to map the risks of multi-use. The risks identified in the analysis are based on potential and general situations that multi-use projects might face given the nature of their activities. The risk analysis identified the five risks with the highest pre-mitigation hazard level per each pilot and an overview of other multi-use risks (Table 2). The results are reported in deliverable 6.3 (UNITED, 2022).

All of this information gathered was used to analyse which factors resulted in transaction costs. Hence analysing which costs, in addition to the costs and benefits for each of the individual economic activities but also the societal costs and benefits, are faced when developing multi use at sea such as the costs of planning, deciding, changing plans, obtaining permits and licenses, resolving disputes and the costs of writing and enforcing contracts.

4. ANALYSIS

4.1. Risk and Uncertainty

Multi-use of the seas leads to intensive use of the environment, in which synergies between activities can be achieved, but it is also possible that conflicts are triggered (Bellanger et al., 2020). Risks are a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action (European Commission, 2017; IMO, 2002). Risks in multi-use at sea can be of different natures and often are related to the uncertainty that characterises this new type of multi-use activity. To manage the risks associated with multi-use at sea, these must be acknowledged (van Hoof et al., 2020), so an analysis of the risks that businesses may face was performed within deliverable 6.3 (UNITED, 2022).

According to the findings presented in Table 2, the difficulty of obtaining full insurance coverage at affordable costs (Dlugolecki, 2000) initially emerged as the primary risk factor across all pilot projects. During the course of the project, this perception of high risk for Danish and Greek pilots diminished to the extent that it no longer represented the major hazard, and they were able to concentrate on mitigating other risks related to their specific activities. The insurance aspect is therefore described more comprehensively in section 4 c. Adverse weather conditions (Diamond, 2012; Kron et al., 2019; Susini et al., 2022) were identified as the top two pre-mitigation risks for three pilots (combination fixed – fixed activity), suggesting that multi-purpose activities at sea are always subject to these hazards and risks, while severe weather is a priority risk for two pilots (combination fixed – mobile activity). Weather conditions are a temporary risk, but high insurance costs are a structural risk. The top risks that follow are more varied and include water quality (water pollution and eutrophication risks), the challenge of facilities decommissioning procedure and costs (Topham et al., 2019), lack of specific regulations and structural failures caused by multi-use activity equipment interactions (van den Burg, Schupp, et al., 2020; van Hoof et al., 2020). The risks identified may slow down the deployment and expansion and the scale-up of multi-use at sea. The risks identified can be direct or indirect and can cause increased costs of implementing multi-use projects, the complexity of procedures and the required capability and capacity of workers working within the site. Several multi-use business risks arise from the uncertainty that characterises these businesses due to their novelty and the lack of specific regulations to govern the interactions between the multi-use activities.

Table 2 – Top five pre-mitigation risks for each project pilot identified in UNITED

Risk Nº	German	Dutch	Belgian	Danish	Greek
1	Inadequate insurance coverage	High cost for obtaining insurance cover	High cost for obtaining insurance cover	Severe weather	Severe weather
2	Severe weather	Severe weather	Severe weather	Potential accidents while entering the site	Travel restrictions for tourists (COVID)
3	Lack of qualified staff	Activity on the site by other multi-use partners	Activity on the site by other multi-use partners	Presence of tourists and workers on the wind farm interacting with the infrastructure	Water quality of the site to ensure the presence and health of fish
4	Water quality at aquaculture production site	Decommissioning of assets	Decommissioning of assets	Lack of specific technology knowledge	Anchoring boats near the site

	and eutrophication risk				
5	Lack of regulations for multi-use at sea	Engineering design solutions interacting	Damage risks of mechanical loads and collisions with vessels/fishing boats	Structure failure	Camera and sensor failure

It should be noted that there is quite a substantial difference whether the project is from the beginning being developed as a multi-use undertaking or, as is quite often the case, multi-use is generated by adding on an activity to an already existing activity. Especially in the case of OWFs quite often the first step in development is the establishment of the OWF site, after which activities such as food production are added. This can lead to sub-optimal situations such as a lower harvest due to the difficulty of setting up the lines and high maintenance costs because the turbines are located far apart. This in most cases results in several different operators involved in the multi-use operations, rather than having a single operator overseeing activities. This does not only lead to differences in operations and activities between the different operators involved but also differences in risk perceptions and risk management options (Stuiver et al., 2016; van den Burg, Röckmann, et al., 2020; van den Burg, Schupp, et al., 2020; van Hoof et al., 2020).

Where innovative approaches and technologies are used, as is required for some multi-use projects at sea, uncertainties remain higher than for more established technologies and business models. The additional costs that are considered contingency risks are an element of the transaction costs investigated in this study (Burke, 1998). A higher risk contingency potentially creates a large number of barriers to the project proceeding, such as the availability of long-term and insufficient funding, punitive interest rates requested from project financiers, excessive insurance premiums and the lack of vision on the part of governments that are supposed to invest through subsidies in innovative sectors. This leads to the inevitable choice of political or business leaders not to proceed with investment in the project because of the perceived consequences of its failure. All could fundamentally undermine the project viability leading to novel projects like multi-use at sea stalling (Al Natsheh et al., 2021).

Project risk contingency can be credibly lowered by finding appropriate risk mitigation actions to reduce the uncertainty of a project. Part of the mitigation actions must be undertaken internally within the company management. It is essential to design the inception project considering potential risks and minimising vulnerability. Likewise, it is necessary to select and develop a design plan for the multi-use production site e.g. by carrying out an environmental impact assessment of the site. These actions are carried out by the project developer who, in addition to setting the initial project requirements, is in charge of designing the operational safety protocols. The development of extensive protocols ensures risk containment in various emergency scenarios. It is important to have health and safety procedures for workers. If the activity involves the presence of tourists, they must also be informed about general safety rules on site. Procedures also play an important role in emergency situations where there is damage to the infrastructure. In addition, a damage coverage and repair plan can be developed.

Maintenance and continuous control of materials and components is essential for risk containment. In this way, detachments and dispersion should be avoided. This is assigned to the role of the site manager, whose responsibility is to monitor the condition of the site with the help of equipment such as sensors and cameras. Multi-use projects can benefit from multi-site managers who can facilitate coordination between activities and local stakeholders. This influences the development of this type of business by enhancing a positive image of multi-use for customers, investors and regulators.

However, not all risks can be addressed internally. Among the main risks identified by the project pilots are legal and regulatory risks. Certain aspects such as the lack of dedicated regulation to stimulate multi-use projects increase uncertainty in these projects, discourage investors and cause delays in the development of multi-use projects. Policymakers could facilitate the formation of multi-uses by, for example, facilitating the obtaining of permits and the creation of ad hoc policies. This would improve the reputation of multi-use projects, which could obtain better financing conditions and lower insurance premiums on their activities.

The consequences of inadequate risk mitigation can lead to severe damage and injury to persons, assets and the environment. If the risk occurs, this can affect the viability of the project and slow down the rollout and scale-up of multi-use. Unless the right mitigation actions are implemented, multi-use projects may be perceived as highly risky, increasing the risk contingency. This could result in the loss of funding and possible investors, leading to the failure of the project. Most of the risks can be partially mitigated internally by the project team, but some aspects need additional actions by other external stakeholders.

4.2. Governance

Governance takes place at several levels, such as the central authority level, the regional, sectorial and/or local authority level and even at the level of the established private operators, in cases where multi-use projects are to be deployed in areas already occupied by other actors. The latter has in many occasions significant power or leverage to (dis)allow any additional (multi-use) activity. To bring about multi-use at sea, it is necessary to comply with the rules and procedures that various institutions have put in place. This includes both public authorities, who for example have control over permits, and the private sector whose own standards also determine what is and what is not deemed possible. The concept of governance is typically used to describe this myriad of rules and regulations. Taking a transaction costs perspective, earlier studies have looked into the costs that public authorities make to implement governance arrangements (Caballero & Soto-Oñate, 2016).

Developers of multi-use (pilots) are confronted with various (governance) costs, ranging from clear-cut costs such as fees and costs for collecting and providing data to intangible costs such as uncertainty about the process and the effort to be put into, for example, to obtain a concession and/or an operational permit. Such costs are by no means unique to multi-use, and in fact, any entrepreneur would have to invest time and resources to obtain a permit. What is unique to multi-use, however, is that there are large differences in how multi-use governance is organised in various countries, which results in different kinds of transaction costs, as became clear in the various pilot cases.

When it comes to multi-use, governance is still under development. In 2016, Stuiver et al. concluded that there are diverse approaches. In some countries, governance was organised, yet in many regions, little was in place, despite ambitions and research interest in multi-use (Stuiver et al., 2016). The MUSES project concluded in 2018 that multi-use as a concept is still novel for government authorities, sectoral bodies and policymakers. These actors must adjust policy, planning, consenting and management in order to advance synergies between maritime uses that are usually managed under different sectoral institutions and owners. Integration and coordination at vertical (across levels of governance) and horizontal levels (across sectors and policy topics) are needed. This may be achieved by setting up cross-sectoral platforms at national level to guide the development of multi-use, involving continuous stakeholder engagement, exchange of knowledge and integration of new multi-use actors (Schultz-Zehden et al., 2018).

Since then, multi-use governance has changed. Multi-use is made possible in various countries, under different governance frameworks and partly stimulated by recent maritime spatial plans (Belgium, Denmark, the Netherlands). Maritime spatial planning offers options to establish multi-use projects, but at the same time, national legal complexity and overlapping competencies of the authorities involved seem to impede the establishment of full-scale multi-use installations or co-location of offshore activities. Whereas the first reduces the transaction cost for multi-use, overcoming the latter complexities comes require significant investments.

Two distinct models for governance are identified, each with a different approach to fixed structures and mobile activities and can be summarized as follows (see Table 3):

- Model 1: from a strictly planned, top-down governance scheme which allow multi-use only within predefined zones and introducing prohibited access for other users [Belgian and German pilot] to a more flexible governance schemes with adaptive management in which the exact location and modalities of multi-use are top-down defined within (larger) zones with flexible application of safety distances to open the option to allow other activities [Dutch pilot].
- Model 2: a very flexible multi-use governance approach between an existing fixed installation and a selected mobile activity (tourism) [Danish and Greek pilot], which lies in between the strictly planned top-down governance model and the flexible bottom-up governance model. It is proposed as a "hybrid" model which culminates the characteristics of the first model into one at a cooperative governance level.

Table 3 – Governance models observed based on UNITED pilots experience

	FIXED STRUCTURE ACTIVITIES (Wind farms, aquaculture) floating solar panels,	MOBILE ACTIVITIES (Fisheries, shipping, tourism)
Model 1 (Belgium, Germany)	Predefined zones, strict procedure, top-down	Strictly regulated, prohibited within zones with fixed structures
(Netherlands)	Predefined zones, adaptive procedure, top-down identified MU with stakeholder engagement, innovation-driven	Strictly regulated access departing from a prohibition, but flexible application of safety distances to open the option to allow other activities (MU) within zones with fixed structures
Model 2 (Denmark, Greece)	Predefined zones, strict procedure, top-down	Flexible application of co-use opens options to operate with fixed structures

If we overlay this typology of governance with the different types of transaction costs, the following observations are made. In Model 1, with strict regulation, predefined zones and strict procedures there is more clarity upfront for multi-use developers on what is possible where, and what is not. Under the Maritime Spatial Planning Directive7, the European Member States are expected to pay attention to the topic of multi-use and justify why particular locations and uses would be more suitable than others. While such a strict approach might mean that multi-use is not possible, from a transaction costs perspective, one could say it lowers the time and resources developers need to invest in getting approval, shifting the burden for multi-use development to the government. Model 2 is a mix of the previous models where mobile activities are dealt with more flexibly, whereas fixed structures have to deal with predefined zones. The resultant transaction costs are different for the various users (Table 4).

[7] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning, OJ L 257, 28.8.2014 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0089

Table 4 - Transaction costs and their distribution by governance models observed.

	Transaction costs	Distribution of costs
Model 1	Low, clear insight in what is allowed where	Assuming the analysis of what can be done by the authorities is done prior, and not paid for by the private sector
Model 2	Mixed picture	Users of fixed infrastructure face lower transaction costs than users of mobile infrastructure.

While the concept of transaction costs has gotten little attention up to date in relation to governance, some past and ongoing developments reflect a concern about the costs involved in planning and obtaining permits. The Dutch approach of developing "gebiedpaspoorten" (area passports) can be seen as a way to reduce the transaction costs for multi-use developers: government-funded studies predefine which uses are most suitable for a specific location, reducing costs for investigations by private sector developers. In a similar vein, protocols and guidelines for multi-use lower the effort to be invested by the private sector into possibilities of multi-use.

Yet, the spectrum of actors involved in governance is broader than governments alone. Private organisations, such as certifiers and insurance companies, play an important role in the governance of multi-use. Discussions with the pilots in UNITED consistently point to the fact that these actors have not yet prepared guidelines or standard approaches to deal with multi-use. Consequentially, developers face high transaction costs when dealing with such actors.

In general, whilst national maritime spatial plans of EU member states promote multi-use to some extent, there is no specific, coherent legal framework in place which facilitates the development of multi-use projects. There is a lack of an integrated environmental approach when several activities with different impacts and longevity are combined in multi-use. For each activity, a single permit and hence Environmental Impact Assessment (EIA) is required. The administrative burden is usually further exacerbated by to lack of cooperation between the different authorities responsible for each individual use. This hinders the smooth development of large-scale multi-use projects. In order to further the development of multi-use a legal framework must be developed in which the different permit procedures are combined into one single process application based on a cumulative EIA for the various uses in a specific area. Joint multi-use concessions should encourage applicants to take account of the risks of each activity in their initial planning and project design. Furthermore, the appointment of a one-stop shop authority, a single authority as final responsible for the coordination and implementation of the total of rules and regulations, permits and licences governing multi-use and the underlying individual activities, is useful, bolstering cooperation between all competent authorities.

All pilots have in common that the safety of shipping has priority over all other uses. In addition, OWF installations need to be decommissioned at the end of their lifetime. Currently, there is still uncertainty about whether installations will have to be dismantled completely or partially when the activity is ended. The decommissioning decision will depend on the future use of the zone and the fixed multi-use activities involved. It should be noted that the end-of-lifetime of these activities may differ such as for offshore wind energy (20 – 30 years) and aquaculture (40 years). Depending on the characteristics of the ecosystem, OWFs may provide interesting new restoration and conservation opportunities for several species and habitats, such as oyster species, that generally have suffered from the impact of fishing with beam trawls and from dredging activities. Since these activities are generally banned in zones where wind farms are located, the establishment of OWFs could give rise to additional restoration opportunities in combination with nature-friendly low-trophic aquaculture. This can be tagged as a specific manifestation of 'nature-inclusive design' (Hermans et al., 2020), aimed at creating win-win opportunities for both economic and conservation-linked interests. Nevertheless, despite the enthusiasm, several legal constraints and bottlenecks might arise when implementing multi-use projects, even when they amount to nature-inclusive design. It will be a legal challenge to use nature-inclusive design as an argument for streamlining multi-use authorization and permit procedures and/or a proper integration into the applicable management plans.

4.3. Insurance

The costs involved in the insurance of a multi-use project have multiple origins. They can be viewed as being (1) entirely external to multi-use and users; (2) internal to the additional user which turns the area previously used by one actor into a multi-use area; or (3) internal to the activity of multi-use itself.

A cost which is entirely external to multi-use, yet which presents a veritable cost for the pilots involved in UNITED, situates itself in the general market context of the marine insurance market. Since 2018, Lloyd's has introduced a yearly exercise (the Decile 10 initiative) to uncover the most underperforming markets. For this exercise all syndicates have to identify their poorest performing portfolios of business. This initiative was in turn replicated by other insurance associations. It was discovered that more often than not the marine and power sectors were indeed in the Decile 10 and therefore part of the most underperforming sectors. Upon this realization, the insurance for these sectors was either no longer offered by many insurance companies or merged with other sectors. This decreased capacity on the market, leading to a corrected pricing for the remainder policies offered. Alternatively, fees were raised significantly. One of the most significant factors for the underperformance of the sector is the substantial increase in large natural catastrophic events. Both 2017 and 2018 were two of the worst combined loss years in history for the marine insurance sector (Lloyd's, 2018). 2020 was the fifth largest catastrophic year on record, with ten more insured events costing more than £1bn each, in comparison to 2017 (Lloyds's, 2020). These phenomena have led to the current reality of decreased capacity, and increased premiums, deductibles (for example a higher monetary amount or a higher number of days for business interruption) and cover restrictions (van der Want, 2021).

When, as currently is the case, insurance policy fees are high, not due to elements related to the project, but rather to the market itself, it will be key to look into the specifics of the insurance policy and weigh risks versus benefits. Firstly, insurance policies can have limits or caps on the amount to be paid out in case of damages. This limit can be set per type of damage and occurrence or overall. The lower this limit, the lower the risk for the insurer, the lower the insurance policy fee. Secondly, deductibles can be introduced or increased. The higher the deductible, be it monetary or calculated in days (e.g., the number of days of business interruption), the lower the insurance policy fee. This is of course a double-edged sword. It will be important to estimate whether a high deductible does not make the policy redundant. This will be the case when the value of the asset to be insured does not outweigh the steep deductible. In such a case, it will be worth considering not to insure the asset. Thirdly, when a certain coverage, such as salvage costs, can be added to either the asset or liability insurance, such coverage should be added to the policy with the lowest deductible. Likewise, it must always be attempted to settle damages under the policy with the lowest deductible.

When a multi-use project is deployed in an area already occupied by another actor, such as a OWF held by a concession holder, the multi-use actor coming into the area later will likely have to shoulder the entire cost of insuring the added multi-use risks. This could be corrected by encouraging the projects to be planned jointly from the beginning, even if the actual commencement of the projects differs. Costs for ensuring multi-use risks can then be shared from the beginning. In addition, as demonstrated by the Belgian pilot, the arrival of the additional multi-use operators to the area can be contingent on demands made by the initial user which can demand a (steep) minimum coverage of damages by the insurance of the additional multi-use user. However, the Danish pilot shows that insurance policies are not always requested to be altered on the demand of OWF operators to cover steep potential damages to turbines. Likewise, no insurance demands were made by the aquaculture operator allowing diving tourism in the Greek pilot. Yet, this does not diminish the fact that the multi-use operator remains liable in case of damages. Therefore, it is crucial to have a contractual waiver of recourse between the different parties of the project in which it is clearly stated they will not claim damages from one another (above the insured limit). It is also an option not to use high-risk zones for multi-use, i.e. zones which contain activities that have risks leading to potentially vast monetary damages due to their nature, as in the case of a wind farm where damages to cables or turbines can easily run into millions of euros. Even when coverage has been adjusted to high-risk zones, most likely a third-party liability insurance will be capped and, in some instances, not cover full damages leaving the multi-use user exposed to the full brunt of severe damages if there is no contractual waiver of recourse.

Finally, an additional cost of multi-use stems from the novelty of the activity and associated unknowns. Insurance fees are for a large part determined by the risks inherent to the project to be insured. This is true for any project to be insured, be it one of single or multi-use. Specifically important for multi-use is that not only the amount and severity of the risks are determinant, but also the access to historical data on the risks. Due to the novelty of multi-use, such historical data is not available to insurers. This uncertainty, also found in the risk analysis conducted with the pilot projects, will translate into higher rather than lower insurance fees. In order to mitigate these elevated fees induced by the novelty of multi-use, firstly, it will be essential to detail the intended multi-use project as much as possible. For the Belgian pilot, a detailed method statement as well as an independent risk analysis was made. Only when an insurer or insurance broker has details about the risk description, risk consequences, mitigation measures, probability and impact will it be able to produce a meaningful risk analysis. Secondly, it will have to be demonstrated that all partners, including sub-contractors, of the project have properly trained staff and their equipment and vessels have gone through all the necessary checks of having correct certification. When working with subcontractors, for example, risks will be deemed smaller when working with an experienced partner with a zero accidents track record. Thirdly, the description of the project should feature how the project plans ahead to reduce damage in the event risks should materialize. This is done by testing equipment nearshore before moving offshore or conducting a computerized simulation of potential risk scenarios taking into account different environmental and circumstantial scenarios, as was the case for the Belgian pilot. The Greek pilot has Remotely Operated Vehicles (ROVs) in place which can log an incident should one occur, immediately clarifying what the circumstances of the incident were.

Other uncertainty-mitigating actions that could play a role in lowering the insurance premium would be the presence of weather stations in situ, vital to inform operators in time of the onset of stormy weather. Similarly, surveillance of the multi-use project by radar, AIS (automatic identification system of vessels) or cameras could provide early detection of drifting equipment before it can provoke damage. In addition, any such footage or data could assist in future insurance applications to demonstrate a lack of incidents. However, of course, care must be taken to limit the cost of additional requirements. For example, the obligation to have AIS when transiting a wind farm can be viewed as a prohibitive cost (Ministry of Infrastructure and Water, 2020) Multi-use could furthermore be limited to the maintenance area of the wind turbines and infield cables. To further reduce vessel traffic, maintenance and other activities should be kept to the bare minimum, for example by having (both distinct) multi-use operators use a single trip for different purposes, or they could be delegated as much as possible to ROVs or autonomous vessels – which in turn decreases the need to insure personnel. For a similar aim, multi-use users could pool activities and share vessels as was done in the Belgian pilot. Finally, and perhaps most simple of all, in order to reduce the risk of collisions, there must be clear visibility of the multi-use project, for example by marking it with clearly visible buoys (Ministry of Infrastructure and Water, 2020).

5. DISCUSSION

Multi-use at sea can be highly beneficial as it allows for the more efficient use of resources, maximizing space utilization, and facilitating the combination of multiple activities. Conservation of oceans, marine ecosystems and resources is one of the key points of the Sustainable Development Goals (SDGs) of the United Nations Agenda 2030 (United Nations, 2022). This framework promotes sustainability and helps address pressing environmental and economic challenges. By integrating different activities such as renewable energy generation, aquaculture, marine transportation and tourism, it is possible to optimize resource exploitation and space allocation. This innovative concept also promotes synergies between different sectors, thereby fostering collaboration and shared benefits.

The adoption of multi-use at sea plays a crucial role in achieving blue growth goals, aligning with the European Blue Growth Strategy (EU, 2021) and the European Green Deal (EU, 2019). Multi-use can offer both ecological and economic benefits and opportunities through economic diversification and more efficient resources management. This is not without its challenges which, as described above, may also entail additional costs for the business and thus discourage the start-up of such activities. By aiming at minimising transaction costs that impact the viability and development of multi-use projects, multi-use can be made more attractive, not only from an environmental and social perspective but also economic and financial.

The integration of multiple activities into a shared marine space brings regulatory complexity, technological challenges, managerial and operational uncertainties and a lack of social acceptance (Bocci et al., 2019; van den Burg, Röckmann, et al., 2020; van den Burg, Schupp, et al., 2020). Such uncertainties can result in additional costs, such as extended timelines for permit requirements, onerous financing interest rates, high insurance costs and regulatory adaptation. However, multi-use businesses can seek internal solutions to mitigate these transaction costs.

Part of the uncertainty associated with the novelty of multi-use can be addressed in the design phase of the project. The incorporation of a comprehensive risk analysis and feasibility studies can help identify potential challenges and hazards at an early stage where they are easier to manage (van Hoof et al., 2020). This can also strengthen the business's image with potential investors and insurance companies which could facilitate the launch of the project on the market. Considering various scenarios and potential outcomes will allow multi-use businesses to develop robust strategies and contingency plans to mitigate uncertainties and minimize associated costs.

Other actions can be undertaken in the initial phase of the project such as the identification of internal managers responsible for specific operational and monitoring issues. Defined roles and responsibilities can mitigate specific risks and increase widespread control over different areas of the organisation. This can be supported by the development of safety and emergency protocols and the training of staff and other site users.

Stakeholder engagement involves a mapping of stakeholders relevant to project implementation, which can be carried out in the initial phase (Stancheva et al., 2022). Early and continuous stakeholder engagement is important to raise awareness and foster actions that simplify the installation process of multi-use projects, e.g. by facilitating the obtaining of permits, communication with regulators and the reputation of these projects. Overall, local stakeholder engagement is crucial for the social acceptance often identified as a barrier to the development of multi-use (van den Burg, Schupp, et al., 2020).

Finally, other internal measures can be taken to minimize transaction costs and reduce uncertainty. Networking and partnerships with similar industries enable the sharing of knowledge, resources and collaboration opportunities that can reduce governance risks associated with sharing maritime space. Conducting market research enables companies to understand market dynamics and show revenue forecasts for funding purposes. Adaptation to existing national and international regulations ensures compliance with the laws governing individual activities, pending the development of more specific policies for multifunctional projects.

Despite internal measures, it is often not possible to solve all the challenges associated with multi-use projects. Systemic changes are needed, such as improving the subsidy and funding regime and promoting harmonious regulatory frameworks that facilitate effective collaboration between all stakeholders to ensure the long-term success of multi-use initiatives. This complexity must be addressed holistically, taking into account all the environmental and social interactions that characterise the marine system (Kannen, 2014). For this reason, projects such as UNITED, which aim to promote and establish multi-use practices, are particularly valuable as they consider various aspects and challenges in the implementation of multi-use projects.

In order to enable multi-use implementation, it is necessary to have all stakeholders and government authorities on board. This will facilitate the discussion of common goals to be achieved and the creation of a shared strategy. The interconnection between activities and users requires the creation of well-defined regulatory, economic, technological and social structures. From the regulatory perspective, having specific regulations for multi-use businesses can be highly beneficial. Clear guidelines can affirm a culture of practice for multi-use in the marine environment that will inform and standardise MU management processes and allow benefits of this approach to be maximised (Gazzola & Onyango, 2018; Schupp et al., 2019). This clarity can foster investor confidence and facilitate the assessment of risks by insurers, encouraging their participation in this emerging industry. Simplifying the permit application process can also promote the development of multi-use projects, reducing the administrative burden and delays often experienced by pilot participants.

The UNITED project highlighted that national and international law in this field is fragmented. There is no homogeneous and consistent discussion of multi-use projects at sea (Przedrzymirska et al., 2021). Integrated coastal zone management (ICZM) and maritime spatial planning (MSP) are European initiatives that are essential tools that improve governance in the maritime sector. They promote homogeneous development in line with sustainability goals by considering the diversification of maritime activities. Legislation for the management of aquaculture facilities is often national and, in some cases regional, but always needs to be harmonised in a more comprehensive legal framework (Kannen, 2014). By establishing a supportive regulatory environment, businesses can make informed decisions, allocate resources efficiently and optimise their transactions, thereby reducing unnecessary costs. An improvement in the multi-use regulatory system will contribute to tackling the uncertainty that still pervades the sector.

The above considerations and the data collected during the UNITED project led to the outcome that the multi-use sector needs more and better connections at different levels. The creation of a network of companies with similar experiences can create a supportive business ecosystem in which to share knowledge, collaborate and exchange best practices. Such networks can result in the diminishing of transaction costs. An example of this is the Dutch Community of Practice for the North Sea[8]. This network consists of entrepreneurs, research institutions, civil society organisations and government institutions. The network seeks to enable multi-use, both inside and outside offshore wind farms, by sharing practical knowledge and experience, stimulating smart innovations and getting collaborative projects off the ground.

A better connection with the regulatory apparatus can stimulate the definition of a coherent roadmap to be followed, which can also be fed by the actual experience of companies and research that has identified the barriers to be overcome. An example of this is the multi-use procedure, development by the UNITED partner North Sea Farmers[9] . Involving local stakeholders can simplify the governance process in relation to other entities operating in the area. Ultimately, this network can strengthen the image of the sector, create credibility and instil confidence in potential investors and insurers, contributing to the growth and viability of the multi-use sector.

[8] Community of Practice North Sea (CoP): https://kennisdelen.rvo.nl/groups/view/244e11b4-4982-410f-ab62-eb94b7e23d51/community-of-practice-noordzee

[9] North Sea Farmers: https://www.northseafarmers.org/sector/multi-use-procedure

6. CONCLUSION

The multi-use pilot projects under the UNITED project faced transaction costs as the actors involved had to come to terms with the new risks and opportunities arising from combined uses. This led to project delays, unforeseen costs, and additional efforts for multi-use businesses, often overlooked during project initiation. In this work, we have identified which additional costs multi-use companies face and the areas where they are most prevalent, using data from the field experience of participants in the UNITED pilot project. By identifying and understanding the nature of the additional costs, it becomes possible to explore and provide effective solutions to minimize transaction costs and align the risk profile of multi-use businesses with that of single-use projects.

The areas we have focused our investigation of transaction costs are risk analysis, governance and insurance. Transaction costs of multi-use projects at sea are often related to the uncertainties typical of a still novel approach. These costs are driven by longer timelines for obtaining licences, onerous financing interest rates, high insurance costs and a complex regulatory framework that is still being developed and updated. In addition to these costs are lost opportunities due to inadequate funding for innovations by governments and private individuals who, discouraged by perceived uncertainties, prefer to invest in established assets, causing the financial sinking of these innovative approaches and the technological, environmental and social benefits that could have been achieved.

A crucial aspect of the minimisation of the transition costs is the reduction of the high uncertainty in this sector. It was illustrated that a good risk analysis done at an early stage of the project allows for the identification of the main hazards the company may face and enables the timely undertaking of mitigation actions. The design phase of the project is also crucial to define the internal risk mitigation managers. Well-informed managers will make their decisions taking into account the problems that may arise from the interconnection of several activities. The decrease in uncertainty will also positively influence the propensity of insurers to cover this type of business by granting less restrictive premiums. It will effectively reduce contingency costs and create an environment that is more attractive to potential new financiers. Some mitigation measures that can be undertaken within the business are accumulating funds to deal with unforeseen damage, recruiting and training qualified personnel, monitoring possible risks, and developing clear safety and emergency protocols.

These actions can minimise certain risks and lower the likelihood of incurring additional costs. By developing an economic, social and environmental strategy supported by the legislative system it is possible to internalise the need to preserve marine resources and space. Streamlining the administrative processes for obtaining permits and funds is a key step for the affirmation and dissemination of the multi-use approach. The required consideration of multi-use in Maritime Spatial Planning underlines the importance of a coordinated effort to achieve the goal of sustainable growth in the marine sector and minimises possible conflicts that may occur with other users of the sea.

Finally, an important issue is the early and continuous involvement of all relevant stakeholders. Local stakeholders own valuable knowledge of the local context, including cultural heritage, environmental and community needs. Their active participation in decision-making processes enables the identification of common objectives adapted to the needs of the local community so that the project enjoys wider social acceptance. It is also important to establish a dialogue with government authorities that can facilitate the creation of targeted policies for this type of business. The exchange of data and information on the experiences of businesses in training can speed up this process, and lead to the creation of a network of actors, users and companies that can trigger co-creation of knowledge and practices useful for the affirmation of the industry.

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