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Review

Soft vs. Hard Sustainability Approach in Marine Spatial Planning: Challenges and Solutions

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Abstract: Hitherto, over 50% of countries with marine waters have established MSPs or launched related legal actions. However, there are still conceptual and practical challenges to be overcome in the development of MSP. In this study, we investigate two main approaches in MSP (hard vs. soft sustainability) through reports, published manuscripts and meeting proceedings in seven pioneering countries (Belgium, Netherlands, Norway, Germany, United Kingdom, Australia, and Canada). We highlight the gaps, challenges, and solutions in each of these approaches. From our findings, there are four common challenges in both soft and hard sustainability approaches as follows: (i) the political framework and inconsistent support of MSP efforts, (ii) insufficient knowledge on social dimensions, (iii) insufficient stakeholder engagement in the diversity of stakeholder's groups or in their contribution to the planning process from the initial steps, and (iv) finding a balance between environmental conservation and economic growth. We recommend that future studies should investigate how MSP can become more adaptive to long-term environmental and economic targets, how effective involving socioeconomic strata is in MSP, and how decision-making tools could help to cover the gaps in MSP. Furthermore, public forums are suggested to be developed to facilitate the systematic sharing of MSP experiences worldwide.

Keywords: marine spatial planning; soft sustainability; hard sustainability; marine zoning; ecosystem-based approach

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1. Introduction

Marine ecosystems are key contributors to human food supply and welfare, energy production, global economies, tourism, biodiversity, global carbon sequestration and oxygen production [1,2]. According to reports from the United Nations (UN), marine and coastal resources and industries contribute to five percent of the global GDP and provide livelihoods for more than three billion people around the world [3]. Around 80 percent of the global transportation of goods is through marine lanes [3]. Marine environments and their resources are, therefore, critical to conserve and be sustainably managed. However, over the recent decades, marine ecosystem sustainability has been increasingly threatened by growing human activities with more demands for marine spaces, acidification, eutrophication, the overexploitation of marine resources, release of hazardous substances into the marine environments and climate change [4,5]. Therefore, the effective management

of marine environments requires a comprehensive understanding of the different pressures posed on marine ecosystems. In addition, a marine management system should consider the changing nature and extent of these ecosystems to ultimately modify a marine ecosystem's structure and functions through "planning" [6,7].

To achieve marine ecosystem management goals, a sustainable planning approach must cover the gaps between societal and economic objectives alongside the state of the environment [5]. In this regard, scientists and policymakers have proposed marine spatial planning (MSP) as a holistic approach to achieving long-term ecosystem-based management goals [8,9]. According to the definition by Ehler and Douvere (2009), MSP is a "public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process" [10,11]. The MSP process is adaptive and continuous and basically includes the following four main phases: (1) Analysis and planning: current environmental situations and human activities are assessed through research. (2) Defining and analysing future conditions: potential future alternative scenarios, as well as temporal and spatial needs for any further demands on ocean space, are identified in the planning region. Subsequently, spatial plans for the sustainable use of sea resources are generated. (3) Implementation: the proposed plan is implemented through regulations, legislation, and investments. (4) Monitoring and evaluation: the effectiveness of proposed strategies, time scales and implementation methods are assessed and modified. The results of this step act as input data for analysis and the planning phase to initiate the whole process again [10,12].

Generally, MSP originates from ocean and environmental communities with the partial involvement of other planning communities, such as land-use planning. In fact, MSP and land-use planning pursue the same goal, which is generally finding a balance between social, economic and environmental values through physical planning [10]. The first MSP was developed with the aim of conserving marine-protected areas in Australia in 1975 [13]. Afterwards, by approval of the EU maritime policy (2006) and the EU maritime roadmap (2009), MSP goals were set to resolve conflicts between the user–user or user–environment with emphasis on economic development in the sea, especially in the North Sea, as a densely used sea area. This MSP approach was implemented in the Northwest European countries of China and the United States [13–15]. The most comprehensive concept of MSP emerged in Australia in the late 1990s, followed by Canada, which considers MSP as a tool for developing human activities in the sea with ecosystem-based approaches (EBA) [13]. This approach takes into account the cumulative impacts of human activities on ecosystem services as well as the ecological integrity and biodiversity of marine ecosystems for the appropriate spatial and temporal planning of human activities in the sea [8,11]. Although EBA was subsequently included in the European Union Marine Strategy Framework Directive 2008/56/EC (MSFD), the European Parliament voted in late 2013 to emphasise economic growth in the form of the Blue Economy while downgrading the emphasis on the EBA in the objectives of the proposed Directive on MSP and integrated coastal management (ICM) [16]. The objective of MSFD is generally to achieve a good environmental status for all of the EU's marine waters by keeping marine ecosystems healthy, productive, and resilient while ensuring the more sustainable use of marine resources for current and future generations [17]. Figure 1 illustrates the objectives of ecosystem-based MSP in Australia and MSFD in European countries. Hitherto, several studies have reported that MSP could resolve issues regarding user–user conflicts (e.g., wind farms, oil and gas fields, shipping, aquaculture, conservation areas, tourism, etc.) in the southern North Sea in the Netherlands, Belgium, United Kingdom, Sweden, United States, Canada, Philippine, and Bangladesh [18–23]. It has also been reported that MSP is the key element in resolving user–environment conflicts in Australia's Great Barrier Reef Marine Park and the North Argentina Basin with a long-term perspective on the conservation of the ecosystem and biodiversity [1,2]. Such experiences demonstrate that MSP can be an effective

approach for controlling/mitigating the impacts of ongoing and future human activities on marine environments.

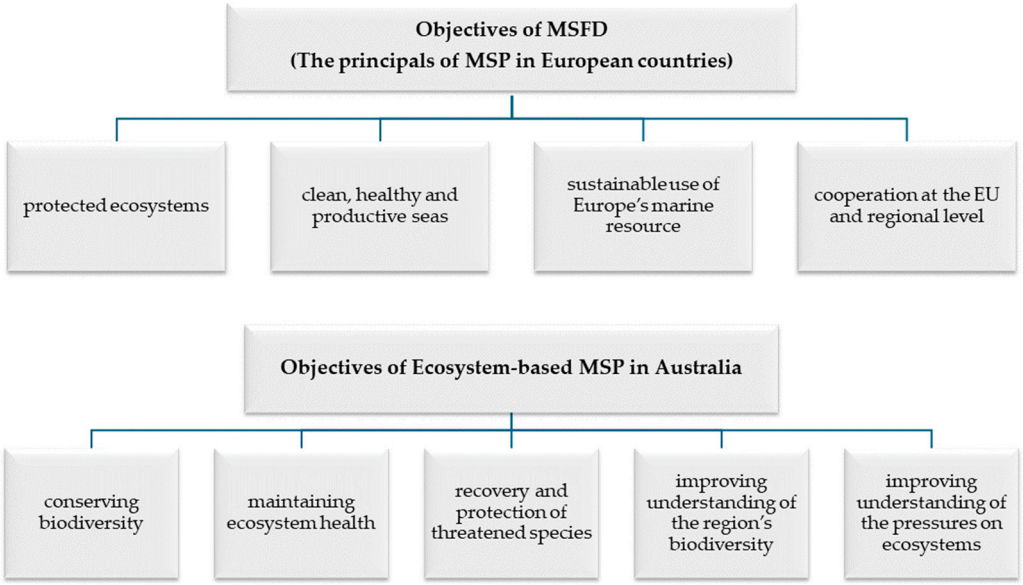

Figure 1. Comparison of MSP objectives in European countries and Australia.

So far, the Intergovernmental Oceanographic Commission of UNESCO IOC-UNESCO and the European Commission have created various guidelines on MSP, in addition to applicable national guidelines and Directives in each country. Meanwhile, more than 75 of the world's 150 countries with marine borders have adopted MSP roadmaps as a strategy for integrated marine management [24]. However, there are significant disparities in the planning process of MSP in those countries. In addition, the MSP process can be affected by the planning culture and national policy design of each country [25]. MSP in Australia and Canada, for instance, is primarily driven by ecosystem conservation objectives, with the assumption that natural resources are irreplaceable if lost (hard sustainability), whereas MSP in European countries, China and the US prioritise economic objectives, with the assumption that the loss of natural resources can be compensated through technological advancement (soft sustainability) [16]. On the other hand, there are still some countries worldwide that cannot launch MSP or are just at the beginning stages of MSP due to constraints, such as a marine data gap or a lack of linkage between authorities for the management of marine environments as a whole [13,24]. According to reports, MSP has been primarily implemented in high-income countries, while only 7 percent of coastal countries in Asia-Pacific regions have implemented MSP in their Exclusive Economic Zone (EEZ) [26]. As a result, implementing MSP at the national level and over the national borders is still challenging. Therefore, the present review study aims to address the challenges and good practices of MSP implementation with either a hard sustainability or a soft sustainability approach over the last two decades to ultimately provide insight for executives/legislators in the nations which are in the early stages of MSP implementation, as well as suggestions for future research on MSP. Accordingly, the main contribution of this study is to enhance an understanding of the obstacles and effective strategies related to implementing hard or soft sustainability approaches in MSP, as well as informing decision making regarding future MSP implementation. For this purpose, data and reports on marine spatial planning were gathered in five case study European countries (i.e., Belgium, Netherlands, Norway, Germany, and the United Kingdom) as examples of front-runners in the hard sustainability approach in MSP, as well as Australia and Canada as successful examples of the soft sustainability approach. A summary of the experiences and lessons learned from MSP implementation in each country is presented in consecutive sections, and at the end, some recommendations are made to fill the gaps for future MSP implementation.

2. MSP Challenges and Good Practices

2.1. Pioneer Countries with Soft Sustainability Approache in MSP

2.1.1. MSP in Belgium

Belgium is known as a pioneer country both in Europe and in the world for implementing MSP with a total sea area of about 0.5% of the North Sea (Royal Decree 2014). The plan cycles were drawn up for a period of every six years the first cycle (2014–2020) was completed, and the second cycle (2020–2026) is now underway [27]. In the early stages, the main driving forces of MSP in Belgium were legal and economic objectives [18]. Afterwards, a "Master Plan" was developed in response to the challenges of conflict among uses, the need for offshore energy production and natural resources conservation. The objective of the "Master Plan" was to provide a spatial vision for current and future uses, with a cross-sectoral and multi-use approach in the entire EEZ and terrestrial sea [18]. As a result, 13 uses are now considered in Belgium's MSP, including nature protection, offshore renewable energy production, shipping, ports, mineral extraction, fishing, aquaculture, underwater cultural heritage, military activities, scientific research, coastal protection, cables and pipelines, and zones for commercial and industrial activities (Royal Decree 2014) [27]. The multi-use approach was reflected in the compatibility/incompatibility uses of the sea in Belgium's marine spatial plan. For instance, normal shipping was considered incompatible in and around wind farms with a safety zone of 500 m; recreational activities could co-exist with marine-protected areas; and sand and gravel extraction were limited to fish-spawning periods (Royal Decree 2014) [18,27]. Plasman (2008), who reviewed the policy perspective of MSP in Belgium, suggested that the first step towards the effective implementation of MSP plans should be aligning scientists with politicians in decision-making processes [28]. The author mentioned that the multi-use approach of Belgium's MSP could provide a delicate balance in time and spatial scales for different activities; for example, sand extraction, fishing, and military exercises could be planned at the same place but at different time spans, whereas offshore wind farms could host clam farms simultaneously as a more creative solution for local fishermen who lost their fishing grounds [28]. Custodio et al. (2022), who studied the linkage between ecosystem services (ES) and the management of marine activities in Belgian's continental shelf, proposed that the engagement of stakeholders is crucial for an ecosystem-based MSP in complex social–ecological systems [29]. The mentioned authors suggested that different stakeholder groups should be selected based on their proportions in livelihood and the economy, and an ES priority list should be provided through stakeholder workshops. This priority list can be applied as a baseline for ES modelling and marine activity management [29]. Vanden Ede et al. (2014), who studied Marine Biological Valuation (MBV) (i.e., the value of the goods and services provided by marine ecosystems) in shallow Belgian coastal zones, suggested that MBV maps should be used along with other social, economic, political, legal and environmental maps for future decision making in MSP processes, especially where conflicts between coastal flood risks and nature-conservation uses of space exist [30]. Similar recommendations were proposed by Pascual et al. (2011) to study the MBV mapping of the Basque continental shelf [31]. Table 1 shows the adaption of MSP in Belgium to the four main stages of the MSP process.

Table 1. Adaption of MSP in Belgium to main MSP stages [10,27].

Main Stages of MSP	MSP in Belgium
Organising the process through pre-planning	The Marine Environment Act was amended in 2012. The Royal Decree of 20 March 2014 adopts MSP. The first MSP cycle was completed (2014–2020). The second MSP cycle (2020–2026) is underway.

Table 1. *Cont.*

Main Stages of MSP	MSP in Belgium
Defining and analysing existing conditions	The draft of the MSP plan includes the analysis of existing conditions. Complementary information is gained by public consultation processes, petition letters, industry, NGOs, and formal contact with neighbouring countries.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions.
Monitoring and evaluating performance	Yearly monitoring of the execution of the plan is conducted through a committee with all competent authorities. The plan is reviewed every six years.

2.1.2. MSP in The Netherlands

The Netherlands, with a total territorial water and EEZ area of about 58,000 km^2, published its first plan and policy document for the sea in 2009 [23]. This country is now in its third cycle of MSP with a priority on renewable energy development [27]. The main drivers of MSP in the Netherlands are maintaining and developing environmental status and ecological habitats on the coast and in the sea, developing wind energy, shipping and sand extraction [23]. The current marine spatial plan includes nineteen uses generally in the sectors of maritime transport, oil and gas exploitation, offshore wind farms, nature conservation, submarine pipelines and cables, aquaculture, fishing, mineral extraction, military, and underwater cultural heritage and tourism [27]. The main strength of the Netherlands' MSP policy is that this country adjusted its long-term perspectives for marine uses and sustainability in accordance with a broader international framework based on the North Sea 2050 Spatial Agenda in response to the European Commission Strategy for "Blue Growth" [27,32]. In addition, the draft of the MSP policy document was prepared by involving national stakeholders and environmental non-governmental organisations from the early stages, as well as international consultation with neighbouring countries [23,27]. However, there were some challenges in implementing MSP at the beginning, including conflict between wind farm development and the oil and gas industry, conflict between wind farms and shipping activities, and reaching a balance between the energy, ecology and food sectors (i.e., fisheries, aquaculture) [23,27]. To overcome these main challenges, a separate executive with an independent chairman was organised to reach interlinked agreements between the mentioned sectors through meetings, open discussions, preparing joint factsheets and an inter-ministerial network [27]. In addition, the multi-use of space was suggested to minimise conflict among uses (e.g., wind farms can host aquaculture, sustainable fishing, and sand extraction recovery activities) [27]. Steins et al. (2021), who studied the role of stakeholder participation in multi-use planning for marine wind farms, marine conservation and seafood in the Netherlands, reported that social, economic, technical and regulatory factors can act as the main inhibitors for multi-use in MSP [33]. The mentioned authors found that collaboration between all stakeholders would be a solution for such barriers; for instance, the Netherlands' government established an independent "Community of Practice North Sea" to achieve a balance between different stakeholders' interests. The main idea of setting up this community was to stimulate the development of multi-use pilots through sharing knowledge and experiences between different stakeholders and encouraging a cooperative culture between them in an informal setting [33]. Garcia et al. (2019) and Hees (2019) proposed that MSP has a positive role in advancing blue energy in countries such as the Netherlands [15,32]. However, since acknowledgement of the licenses and permits of large-scale electric generation projects is usually outside the responsibility of marine authorities, the mentioned authors suggested that MSP should be applied in cross-border dimensions as a multi-level governance system at an international

level [15,32]. Table 2 shows the adaption of MSP in the Netherlands for the four main stages of the MSP process.

Table 2. Adaption of MSP in the Netherlands to main MSP stages [10,27].

Main Stages of MSP	MSP in The Netherlands
Organising the process through pre-planning	The National Water Act and the first plan for the sea published was in 2009. The first cycle (2009–2015) and second cycle (2016–2021) of MSP were completed, and the third cycle (2022–2027) is underway.
Defining and analysing existing conditions	The draft of the MSP plan includes the analysis of existing conditions. The National Water Plan considers all relevant land–sea interactions. For various sectoral interests, specific legislation is in place; for instance, the Electricity Law regulates offshore renewable electricity to be landed, and the Common Fisheries Policy of the EU is in place for sustainable fisheries. In addition, a Community of Practice was established in 2018 with the aim of working in sync with science and government agencies and sharing up-to-date information on the present condition. Furthermore, a consultation body, "Overleg Fysieke Leefomgeving", was established for stakeholders' engagement and understanding of existing conditions.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions. The Policy Document on the North Sea 2016–2021 includes a framework vision map regarding the Netherlands' MSP.
Monitoring and evaluating performance	A review of the Policy Document was carried out in 2018 under the National Environmental Vision to conduct further analysis into the impacts on the environment, as well as separate monitoring and the general evaluation of the good environmental status of the sea. A review of the plan started in 2022 to meet 2030 and post-2030 renewable energy targets.

2.1.3. MSP in Norway

Marine management plans in Norway cover the whole area from the shoreline to offshore. The Barents Sea sector of the Norwegian EEZ is covered by an ecosystem-based MSP plan that was authorised in 2006 and subsequently amended in 2011 and 2015. In the meantime, the Norwegian EEZ's part of the North Sea and the Norwegian Sea were covered by an MSP plan authorised in 2013 and 2009, respectively [27]. The policy design for MSP in Norway was first finalised in 2006, which serves as both a marine spatial plan and a marine strategy [25]. The core element in policy formulation in Norwegian MSP is performing an environmental impact assessment for each maritime sector before its combination into a cumulative impact assessment [25]. Surís-Regueiro et al. (2021) studied the direct economic impacts resulting from the implementation of MSP policies in Norway. The authors reported that there is a significant positive effect of MSP implementation in the Norwegian Sea in contrast to stakeholders' beliefs. From their results, MSP implementation increased the production value of marine industries in the Norwegian Sea to about EUR 2262 million in 2013-16. The authors suggest that it is critical to develop protocols and procedures for gathering and processing the information provided by stakeholders in similar studies and estimations [34,35].

Kirkfeldt et al. (2020) conducted an interview with Norwegian planners to find a balance between the interests of different sectors in Norway [25]. Their study showed that one of the main challenges of Norwegian MSP is to resolve competing interests among sectoral stakeholders and homogenising legal frameworks across sectors and geographical

locations, as well as challenges regarding the lack of a legal framework for marine-protected areas (MPAs) in the EEZ. The authors suggested that MSP should be implemented in the first place alongside making some changes to policy design wherever it is needed. These changes can come through good practices and experiences that already exist in other countries with a longer MSP experience. This approach helps to make more capacity and resources available to address other challenges that may arise during MSP implementation [25]. Olsen et al. (2014) studied the challenge of integrating multiple stakeholders and governmental levels in MSP in Norway, Belgium, and the US. The authors found that both Norway and Belgium have successfully fostered horizontal integration across sectors by establishing neutral meeting spaces (i.e., round-table meetings) where all stakeholders can participate. Similarly, vertical integration between government tiers has been accomplished in both nations by aligning parliamentary processes with executive government levels while also incorporating input from stakeholders [34]. Table 3 shows the adaption of MSP in Norway to the four main stages of the MSP process.

Table 3. Adaption of MSP in Norway to main MSP stages [10,27].

Main Stages of MSP	MSP in Norway
Organising the process through pre-planning	Pre-planning started in 2002. The first generation of plans was put into place for the Barents Sea-Lofoten area in 2006. The Nature Management Act was approved in 2008–2009. A new Marine Resource Act entered into force in 2009. MSP for the Norwegian Sea and North Sea–Skagerrak was launched in 2009 and 2013, respectively.
Defining and analysing existing conditions	The draft of the MSP plan included the analysis of existing conditions. The monitoring group, the forum for integrated ocean management, a steering committee of 10 ministries led by the Ministry of Climate and Environment, and an interdisciplinary MAREANO programme for mapping the seabed in Norway's marine and coastal waters provided complementary information on analysing existing and future conditions.
Defining and analysing future conditions	The draft of the MSP plan included the analysis of future conditions.
Monitoring and evaluating performance	The monitoring group, established in 2006, is responsible for the environmental monitoring of the marine ecosystems in Norwegian sea areas. The monitoring group annually produces short-status reports of all Norwegian sea areas, where every four years, a more detailed report is produced on the environmental conditions and development of all three sea areas. In addition, a supplementary report on the environmental status of pollution in the Norwegian Sea areas is produced every four years. The MSP plan is reviewed every four years, based on an updated cross-sectoral factual basis. The last update for all areas was endorsed by Parliament in June 2020. New updates are scheduled for 2024.

2.1.4. MSP in Germany

Germany, with a territorial sea and EEZ area of about 21,400 km^2 and 33,000 km^2, respectively, first started MSP in 2009. The objectives and principles of spatial planning in the German EEZ are based on the Spatial Planning Act of 1998, which considers economic and scientific use along with ensuring the safety and ease of maritime shipping and also the protection of the marine environment. Current maritime uses include mining, fisheries, aquaculture, coastal protection, ammunition storage sites, underwater cultural heritage and radars [27]. One of the strengths of MSP in Germany is considering the possibilities of transnational cooperation programs in the North and Baltic Sea regions in the planning process. Accordingly, transnational cooperation is provided with the participation of states and federal institutions with the aim of the sustainable development of these marine areas. Another strength is the involvement of coastal stakeholders in the planning process through consultation [27]. However, some challenges in implementing MSP in the German EEZ have been reported in different studies. For instance, the accomplishment of climate targets and the creation of jobs are the main justifications for developing offshore wind farms in Germany. However, local communities disagree, alleging possible impacts (e.g., environmental and landscape impacts, conflicts with fishing and shipping and freedom and wildness of the sea). Therefore, local support for particular sea uses also depends on cultural and regional distinctions as well as local demands [36]. Kannen (2014) suggested that it is indispensable to consider interactions between the social and ecological components of MSP through the involvement of local people in the planning and decision-making process [36]. Gimpel et al. (2015), in the study of the co-location of offshore wind farms and aquaculture in the German EEZ, proposed that a geographic information system (GIS)-based framework can be an effective tool for the site selection of an activity where conflict of uses exist [37]. Stelzenmüller et al. (2016) demonstrated that the socioeconomic importance of spatial overlap is affected by planning boundaries in the German EEZ [38]. The authors suggested that an interdisciplinary bottom-up strategy that takes into account the ecological consequences of human activities on target species helps to identify potential multi-use sites. As well as this, the following major issues must be resolved in order to develop the idea of multi-uses into MSP practice: defining a legal basis; enforcing safety regulations; defining the minimal specifications for each activity to be conducted in areas of other compatible activities (capacity, quotas, technical equipment); implementing a licensing process; and identifying financial subsidies to help businesses develop compatible activities [38]. Jay et al. (2016) proposed that communication between different stakeholders and their perspectives on the ecosystem approach within the MSP process can facilitate the development and implementation of the concept [39]. Berkenhagen et al. (2010), in their study of decision bias in the marine spatial planning of offshore wind farms in the German EEZ, suggested that the singular assessment of the economic impact of different activities is a drawback in the MSP process. For instance, assessments do not consider displacement costs when fishermen are forced to concentrate their efforts on small fishing grounds left open to fishing after the installation of all wind farms, which likely result of increased competition among fishermen and a rapid decrease in catch rates and subsequently no yield benefits [40]. The authors suggested that cumulative economic impact studies are substantial in MSP, and the following points should be taken into account: indirect costs associated with the displacement of activity to other areas (e.g., higher fuel costs, etc.), marine habitats and the species affected by the wind farms, an assessment of the cumulative effects of the closure of fishing areas due to wind farms, shipping, military activities, marine-protected areas, and other uses [40]. Table 4 shows the adaption of MSP in Germany to the four main stages of the MSP process.

Table 4. Adaption of MSP in Germany to main MSP stages [10,27].

Main Stages of MSP	MSP in Germany
Organising the process through pre-planning	The national legal basis for MSP in the German EEZ is the Spatial Planning Act (i.e., ROG Act), which was last revised in 2008 and amended in 2017. In 2004, MSP was included in the law for the first time. The legal regulation on spatial planning came into effect in 2009. According to the Spatial Planning Act, the federal government is responsible for MSP in the German EEZ.
Defining and analysing existing conditions	The draft of the MSP plan includes the analysis of existing conditions. The federal government carries out the preparatory procedural steps for drawing up the spatial planning plan with the consent of the Ministry. These include the creation of preliminary drafts and plan alternatives, the implementation of environmental assessments, the preparation of environmental reports and the participation of the public, those responsible for public affairs and other stakeholders.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions.
Monitoring and evaluating performance	According to the Federal Spatial Planning Act, the MSP has to be reviewed at least every ten years. According to the MSP Ordinance 2021, the plan is to be evaluated every 5 years.

2.1.5. MSP in the United Kingdom

The legislative framework for marine spatial plans in the United Kingdom (the UK) was first submitted in 2009 with the long-term consideration of actions (i.e., 20 years) and three-year evaluation periods. Subsequently, the marine policy statement was adopted in 2011, which established a policy framework for holistic marine planning and management in the UK waters [15,27]. MSP in the UK runs independently in England (11 marine plan areas in the east and south inshore and offshore waters), Scotland (one strategic national plan and 11 regional inshore plans), Wales and Northern Ireland (one plan in each nation both for offshore and inshore waters) [24,27]. The territorial sea and EEZ area of England covers around 51,700 km^2 and 178,600 km^2, respectively [27]. The main drivers of MSP in the UK are the optimum use of space and coexistence the activities, protecting marine resources, alongside sustainable development. The MSP includes fifteen main uses of the sea, including offshore renewable energy, fisheries, aquaculture, ports, shipping, military activities, conservation, coastal protection, scientific research, marine aggregate extraction, oil and gas extraction, cables and pipelines, underwater cultural heritage, tourism and leisure, and the dredging and disposal of dredged materials [27]. The main strength of MSP in the UK is the identification and participation of different stakeholders at the early stages of planning processes through workshops and research projects by the Marine Management Organisation (MMO) [27,41,42]. As well as this, in order to avoid common issues and ensure the better development of successful approaches, MMO gathered and analysed good practices on MSP from Australia, Belgium, Canada, Germany, Netherlands and the USA alongside referencing UNESCO's "Marine Spatial Planning—A Step-by-Step Guide". Ansong et al. (2021) studied a practical approach to building capacity in MSP in European countries and reported that there is a gap between the teaching and implementation of MSP in the UK [41]. In fact, the MSP process in the UK launched before establishing structured courses and training on marine planning. Therefore, there was a

lack of comparison between theory and practice by trained marine planners. To overcome this drawback, MMO and the Welsh government, as the public administrators, provided internal training for their MSP team [41]. Furthermore, the government established three academic degrees specifically on MSP, making the UK the country with the most degrees on MSP [43]. Universities and administration organisations in the UK have also participated in different transboundary projects for an effective exchange of experiences along with the enhancement of MSP implementation both at the national and international level (e.g., the collaborative MASPNOSE project [44] with Germany and the Netherlands to enhance interactions between stakeholders and fisheries, the ADRIPLAN project [45] for boosting the methodology for MSP implementation in the Mediterranean region, and the TPEA project [46] for testing a cross-border MSP in the Eastern Atlantic).

Another positive point of the UK's MSP to address uncertainties of loss and damages to the marine environments is its multi-phased approach to the co-siting of emerging activities. For instance, since the long-term environmental effects of marine renewable energies are still not clearly known, a "survey-deploy-monitor" method has been applied to licensing marine renewable energy activities in marine-protected areas. This method proposes the single-unit deployment of a device at the first step and suggests that the environmental impacts of one device may be assessed before a decision is taken on a more extensive deployment of several devices [47,48].

Brennan et al. (2014) reported some challenges and solutions of MSP in the UK. For instance, to fill the gap in data for planning processes, the authors proposed improving data collection and exchange between authorities [49]. Similarly, Rodwell et al. (2014) reported that there are data quality/availability gaps, incomplete or missing metadata, non-uniform data formats and restrictions on access and licensing in the UK's MSP. The authors suggested that these gaps necessitate high-level assistance from committees and authorities to provide proper data access and discovery for the public as well as maintain data credibility. To overcome this challenge, the UK government has put more emphasis on data standards and data gathering and management, even for short-term projects [50]. The challenge of the insufficient participation of stakeholders in the planning process was suggested to be resolved by making MSP more flexible and adaptive rather than overly prospective. A flexible MSP can provide the effective handling of changing circumstances and attract new information as well as encourage stakeholders' engagement [43,49,50]. Regarding the financial challenges and insufficient human resources, the authors suggested the reallocation of resources from other areas or seeking additional funding from external resources [49]. To solve the challenge between fisheries and marine renewable energy development, a workshop was held to discuss the concerns and solutions of the interested stakeholders. In this workshop, monitoring programs were suggested as a solution to observe and assess the impacts of marine renewable energies on fisheries with the ultimate goal of developing collaboration between these two sectors. In addition, financial impacts on the fishery were suggested to be alleviated by mitigation strategies rather than financial compensation. Accordingly, a strategic mitigation fund was established to support communities and projects on local fuel supply while local boats were engaged in survey works [15,50]. Moreover, a fisheries mitigation working group was established and is being funded by the Natural Environment Research Council Knowledge Exchange Program [50].

Gissi and Vivero (2016), in their study on the challenges of the structuring transdisciplinary nature of MSP in educational courses and training in the UK, proposed that teaching skills and content on environmental and economic perspectives on marine resources alongside knowledge on maritime affairs, legislation and laws are necessary for development of an educational course specifically focused on MSP while planning theory and practical experiences in MSP should not be neglected [43]. Table 5 shows the adaption of MSP in the UK to the four main stages of the MSP process.

Table 5. Adaption of MSP in the UK to main MSP stages [10,27].

Main Stages of MSP	MSP in the UK
Organising the process through pre-planning	Under the Marine and Coastal Access Act 2009; the Marine (Scotland) Act 2010; and the Marine Act (Northern Ireland) 2013, marine planning was introduced for the "UK marine area", which included the territorial seas and offshore area adjacent to the UK. A marine policy statement was adopted in the UK in 2011. Marine planning functions for the Scottish and Welsh marine areas were devolved by the Scottish and Welsh governments, respectively. The MMO is responsible for preparing MSP in England.
Defining and analysing existing conditions	The draft of the MSP plan includes the analysis of existing conditions. The MMO is responsible for the delivery of planning, in addition to the licensing of marine activities, fisheries management and enforcement functions. MMO maintains a marine information system, as well as a strategic scoping exercise, which allows stakeholders to view and comment on the data layers and evidence base with the aim of analysing current and future conditions and uses of the sea.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions.
Monitoring and evaluating performance	According to the Marine and Coastal Access Act 2009, the effect of the policies in the marine plan; the effectiveness of those policies in securing the objectives for the marine plan; and the progress being made to secure the objectives are revised using a logic model with indicators for policies at different stages in the logic model every three years.

2.2. Pioneering Countries with a Hard Sustainability Approach in MSP

2.2.1. MSP in Australia

Australia, with an EEZ area of 9 million km^2, the third largest in the world, introduced zoning for the Great Barrier Reef Marine Park (GBRMP) in 1975, which is known as the first example of MSP in the world [24,27]. In the initial plan, around 4.5% of GBRMP was designated as a protected area in 1981 [51]. However, monitoring and periodic evaluation revealed that ecosystem preservation targets had not been attained; thus, the protected zone was expanded to approximately one-third of the overall area of the GBRMP. In the late 1990s, an ecosystem-based approach to MSP in Australia was launched by establishing the platform of "marine bio-regionalization" to map the location, composition, and structure of benthic organisms for the finer-scale planning and management of the sea [24,51]. Accordingly, Australia's Commonwealth waters (from 3 to 200 nautical miles) were classified into different bioregions based on biological similarities, species distribution, and the geomorphological characteristics of the seabed [13,52]. Bioregional plans (i.e., plans for the North-West, North, South-West, and Temperate East regions) were subsequently developed considering human activities, economic benefits, legal obligations, environmental protection and potential threats to ecological sustainability, protected areas, and species [13]. Each of the marine bioregional plans contributed to the enhancement of decision-making processes under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), specifically with regard to the preservation of marine biodiversity and the sustainable use of oceans [53].

Generally, the ecosystem-based approach for MSP in Australia includes the following three stages: (1) a bioregional profile of the area was created to understand the ecology and biophysical characteristics of the area; (2) a draft plan was created to assess the impacts and

threats of current and future human activities on marine ecosystems; (3) a bioregional plan was developed with the identification of priorities for action in each bioregion. The legal basis for the ecosystem-based management of marine areas in Australia was established in 2005 [51,52]. The main strength of Australian MSP is its richness in spatial data of important biological features, species habitats, and species group levels alongside the pressure analysis of planned activities as the underlying materials of planning. As well as this, the Minister and the Department of Environment in Australia are responsible for evaluating whether a proposed project of human activities in the sea interferes with critical ecological processes or protected marine biota. The data provided in the Australian MSP are accessible for use by marine industrial planners to understand whether a referral is necessary or not. Therefore, the whole process is closely connected to the EPBC Act (1999) [52]. Pressure analysis studies of human activities on the sea before the planning process is another strength of ecosystem-based management in Australian MSP.

According to the survey results of Zimmerhackel et al. (2023), most stakeholders are concerned about the responsibility for maintaining and decommissioning artificial structures in the Australian sea, as well as clean-up costs in the event of an accident. Their findings highlighted the significance of clear rules for both phases in order to minimise the conflicts associated with man-made marine structures. The authors proposed that for a successful MSP, it is essential to understand the relationship between people and marine areas, as well as public perceptions of artificial structures. In this regard, if the policymakers want the public's support, they must explain the environmental benefits of artificial structures. Furthermore, the authors proposed that access to man-made marine structures, job creation, business profits, and user well-being are key societal values that should be included in the MSP process [54]. Barriers to the integrated management of marine ecosystems in MSP in Australia were pointed out by Stephenson et al. (2019, 2023) which included the following: (i) the lack of efficiency of multisectoral management; (ii) disregard for the relationship between cultural, social and economic aspects; (iii) lack of knowledge of the cumulative impact of human activities; (iv) insufficient attention to other experiences and best practices around the world; (v) the lack of supporting legal frameworks; and (vi) complexity or fragmentation in policies and legal obligations [55,56]. Domínguez-Tejo and Metternicht (2019) studied coastal planning in New South Wales, Australia. The authors identified a challenge in the planning process of the study area that arose from insufficient ecological and social data. To address this issue, the authors proposed that combining Bayesian Belief Networks and computational models with GIS could comprehensively handle data limitations/uncertainties in the MSP process while also facilitating marine management through the simulation of various management scenarios [57]. In this regard, Kobryn et al. (2018) implemented an internet-based public participation GIS system for collecting spatial information on cultural ecosystem values in the Kimberly coastline, Australia. The authors suggested that the online-public participation GIS system could be useful for including socio-ecological data as well as cultural ecosystem values in MSP, especially in long, remote coastlines with different stakeholder interests, where traditional methods such as interviews and workshops are not practical [58]. Moore et al. (2017) found that at least 30% of near-shore marine-protected areas in the Kimberly coastline, Australia, had conflict potential with other marine uses. They proposed participatory mapping as a technique for incorporating social data in planning processes alongside predicting conflict potentials. Accordingly, social data were collected by extensive face-to-face interviews for the subsequent mapping of place values. The authors concluded that biodiversity, physical landscapes and aboriginal culture are the most important values in decision making, which should be classified into both compatible and incompatible categories to understand the potential of conflict in MSP. They suggested that social data should be considered along with stakeholders' participation in MSP, especially in the case of marine-protected areas [59]. Another survey in the same study area showed that local and non-local people had generally similar perspectives in mapping values in MSP, with slightly different priorities in management preferences in MSP on the wildness value and biological/conservation value for non-local

people and recreational fishing values for local people. The authors proposed that future MSP should widen representative stakeholder groups to include opinions from a larger community and, thereby, public values [60].

According to Bach et al. (2019), there are still insufficient benthic habitat maps in Australia, making it challenging to establish reserved areas for biodiversity in MSP with a habitat-based management approach. The authors investigated fish assemblage compositions along an inshore-to-offshore gradient (3–23 m depth) and in two marine reserves in Western Australia, 70 km apart. Their findings revealed that the depth and distance from the shore had a substantial effect on the richness and quantity of fish species in the two studied locations [61]. Similar results were reported by McLean et al. (2016) in the Pilbara bioregion in north-western Australia [62]. It was suggested that while developing regional marine reserves, reserved area boundaries should include the entire depth gradient as well as the entire distance from the shore to offshore in order to fully account for fish migration patterns. Stratified sample methods are also beneficial for understanding the effect of the depth and distance from the shore within a habitat type in monitoring the outcomes of MSP when selecting reserved areas for biodiversity [61,62]. Table 6 shows the adaption of MSP in Australia to the four main stages of the MSP process.

Table 6. Adaption of MSP in Australia to the main MSP stages [10,53].

Main Stages of MSP	MSP in Australia
Organising the process through pre-planning	In 1998, Australia's Oceans Policy was released and established an MSP process for the entire commonwealth marine jurisdiction. Under the EPBC Act 1999, marine bioregional plans were developed by the Department of the Environment and cover the commonwealth marine area (i.e., beyond the outer edge of state/territory waters to the seaward boundary of Australia's EEZ) in each marine region.
Defining and analysing existing conditions	The draft of the MSP plan included the analysis of existing conditions. The regional pressure analysis was informed by peer-reviewed scientific literature, and its findings were subject to external review by experts in the relevant fields. The proposed marine bioregional plan was made public for a 90-day period of public comment. The views collected from stakeholders and the general public were considered in finalising the plan. Through marine bioregional plans, the Environment Minister and the Australian government had access to comprehensive information about each marine region. The information is also available to the general public and those planning activities in the Commonwealth seas or actions that have a substantial impact on the Commonwealth marine environment.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions.
Monitoring and evaluating performance	After the first five-year review of Australia's Oceans Policy, its focus changed from a broad multiple-use perspective to an environmental one. The EPBC Act was independently reviewed in October 2009 and the final report suggested a number of changes to bioregional marine planning.

2.2.2. MSP in Canada

Canada, with a territorial sea (12 nm zone) and EEZ area of 200,000 and 2,900,000 km^2, respectively, is the most pioneering country in the world to implement the Ocean Act of 1996, the world's first comprehensive law on integrated ocean management. The aim of

this law is to sustainably protect and develop the oceans [24]. Afterwards, the marine ecosystem-based management policy in Canada was published in 2002 [52]. Following that, the Canadian MSP advanced from 2011 to 2016 by approving four sub-regional MSP plans, as well as a general framework plan and implementation strategy, through the development of the Marine Plan Partnership for the Canadian Pacific North Coast (MaPP) [24]. The main drivers of MSP in Canada included ecological and biological diversity conservation, economic growth, and social objectives. As a result, 16 uses are now considered in Canada's MSP, including offshore renewable energy, oil and gas, shipping, ports, military, ammunition storage sites, fisheries, aquaculture, scientific research, coastal protection, nature conservation, disposal at sea, traditional uses, tourism and leisure, underwater cultural heritage, and cables and pipelines [27].

One of the challenges in MSP in Canada has been the lack of sufficient fine-resolution special data for assessing the suitability of a habitat for conservation [63,64]. In this regard, Ban et al. (2009) studied scientific and community-based approaches in marine-protected area sites for selection in two regions in British Colombia, Canada. The authors conducted individual and group interviews to better understand the community's priorities. As well as this, Marxan software was employed as a decision support tool to identify the scientific priorities for selecting marine-protected areas based on biotic and abiotic criteria. Their findings revealed that the final maps of community-based and scientific-based priorities were strikingly comparable. Furthermore, when spatial diversity in human impacts on marine regions and commercial fishing were considered, Marxan analyses revealed different scenarios from each constituent map [65]. According to the authors, these findings emphasise the necessity of merging community-based and scientific planning techniques into conservation initiatives in order to achieve community support and maximise conservation benefits. Furthermore, people's assessments based on traditional ecological knowledge may be a reasonable substitute for scientific methods for selecting ecologically important areas [65]. Kinlan et al. (2020) implemented the maximum entropy predictive model to map deep-sea corals in North Carolina and the Gulf of Maine on Canada's border to estimate the distribution of corals. They found that this model can be useful in mapping deep-sea biodiversity in order to assign conservation zones in MSP, particularly in areas with logistical barriers and high costs for exploration [66]. Ban et al. (2010) investigated the cumulative impacts of thirty-eight human activities on benthic, shallow pelagic and deep pelagic communities in Canada's Pacific waters. Their study showed that the entire continental shelf of the Pacific marine waters of Canada was impacted by human activities to some extent. Among all the studied activities, commercial fishing, land-based activities, and maritime transportation had the highest share in the total cumulative impacts on marine waters, with almost 57%, 19%, and 18%, respectively. The authors proposed that cumulative impact maps could be useful for planning decisions, especially in allocating conservation areas in MSP and reducing strategies in human-induced stressors [63].

Bennett et al. (2018) believed that the challenge of conflict and competition between marine uses in Canada could be exacerbated in the future, particularly given the country's commitment to global marine protection targets (i.e., 10% protection of its marine areas under the Convention on Biological Diversity). In addition, MSP should provide indigenous communities with equal access to ocean and coastal resources and spaces, particularly in the fisheries area, in order to secure their well-being under integrated coastal management. However, there is currently a lack of data and information concerning the effects of access to ocean resources on indigenous community's well-being, necessitating additional research on the subject [67].

Eger and Courtenay (2021) identified some challenges in integrated coastal and marine management in the Bay of Fundy, Atlantic Canada, including insufficient diversity in stakeholder groups, policy fragmentation and a lack of a solid structure to sustain practices. Furthermore, because Canada's current marine socio-ecological management system is sector-based, with ultimate decision-making delegated to federal and provincial departments, the challenge of inconsistent commitment by legal authorities persists, with new

mandates, priorities and commitments established for each new electoral cycle and political landscape [68,69]. It has been proposed that official and informal mechanisms that facilitate the horizontal and vertical integration of policies across departments can be helpful to overcome the mentioned gaps in the management of the Bay of Fundy, Canada [68,70]. McGee et al. (2022) proposed that advisory committees with representations from regional and sub-regional interests are critical to successfully engage a diverse set of stakeholders in the planning process [71]. In this regard, an MaPP organisation was recently established in British Columbia as the first national government in Canada to achieve a collaborative MSP with different provinces. This experience is considered a successful example of MSP practice in Canada, with the goal of protecting the cultural and economic values of indigenous communities while also promoting marine conservation. In this approach, sub-regional plans were initially prepared by the First Nations and then reconciled with the provincial government and stakeholders in MaPP with the supervision of the Ministry of Forest, Lands and Natural Resources. This strategy enabled comprehensive engagement from the level of the First Nations to the Ministry on all aspects of planning and implementation while safeguarding the First Nations' governance and economy, their cultural values and activities, and resource management goals [72,73]. Table 7 shows the adaption of MSP in Canada for the four main stages of the MSP process.

Table 7. Adaption of MSP in Canada to main MSP stages [10,27].

Main Stages of MSP	MSP in the Canada
Organising the process through pre-planning	The primary legal basis supporting MSP in Canada is the Oceans Act (1996). The marine ecosystem-based management policy in Canada was published in 2002. Canadian MSP advanced from 2011 to 2016 by approving four sub-regional MSP plans, as well as developing the general framework of MaPP. The national authority in charge of MSP is Fisheries and Oceans Canada.
Defining and analysing existing conditions	Pathways of the Effect National Working Group (PoE-NWG) was developed for ecosystem-based marine planning for planners and decision-makers in Canada. In addition, a PoE model was developed to analyse a fact-based relationship between human activities and their associated sub-activities and the pressures and environmental effects or impacts they may have on a specific ecological or biological function that needs protection. Also, relevant sectors are involved throughout the MSP process with the aim of the comprehensive analysis of existing conditions.
Defining and analysing future conditions	The draft of the MSP plan includes the analysis of future conditions.
Monitoring and evaluating performance	Processes for planning revision, performance monitoring and evaluation are not defined under policy/legislation.

3. Emerging Issues for Future MSP Strategies

As MSP strategies continue to evolve, several future challenges are poised to shape their effectiveness and implementation. MSP frameworks will need to adapt to these dynamic and interconnected challenges by incorporating resilience-based approaches that integrate scientific knowledge, stakeholder perspectives and governance mechanisms to ultimately promote sustainable and resilient marine ecosystems for future generations. The future challenges for MSP strategies can be summarised as follows:

- **Prioritisation**

In theory, the ultimate goal of MSP is to achieve both "development" and "conservation" in the marine area. However, not all MSP practices have been successful in achieving this objective. In fact, in many countries, MSP has been a tool for "economic development" with little sustainability or environmental conservation considerations (soft sustainability) [24]. In some other countries, by contrast, ecosystem conservation is prioritised over economic development (hard sustainability). Along with the socio-political priorities of each country, the reason could be attributed to the total surface area of the countries' EEZ zones; that is, there is less competition for space between users in countries with the largest EEZs in the world, such as Australia (6%) and Canada (3.9%), compared to countries with a dense EEZ area, such as the Netherlands (0.1%) or Belgium (0.002%). As a result, choosing the MSP approaches (i.e., hard sustainability or soft sustainability) and challenges must be explored in the context of national borders within a broad cross-border perspective. In this regard, a continuous learning process and the incorporation of lessons learned are critical to guarantee both the sustainability and integrity of MSP [24].

- **The approach**

On the other hand, many countries mistakenly employ zoning as a substitute for MSP; nevertheless, zoning is only a management tool for implementing MSP. In fact, national MSPs should be incorporated into a broader international scale to appropriately understand the cumulative impacts of their activities on marine ecosystems at a larger scale and then employ zoning in ecologically meaningful units [14,74].

- **Data and data Standardisation**

Another challenge in implementing MSP with either soft sustainability or hard sustainability approaches is the access to high-quality data and a lack of implementation tools that can effectively encourage public discussion [36,39,74]. Moreover, conceptual ambiguities in the used terms (e.g., strategy planning versus zoning-based planning, potential areas versus exclusion areas, etc.) may need to be clarified with a glossary of terms to provide effective communication among stakeholders and for cross-border cooperation.

- **Permanent education**

It is important to note that, currently, the MSP team in many countries include policymakers, GIS specialists, fisheries experts or biologists, while MSP has a transdisciplinary nature on its own and, therefore, permanent education is critical. In this regard, developing academic degrees and training experts and specialists in this field with the knowledge of environmental conservation, environmental planning, and economic and maritime law could be an effective measure. Another strategy could be developing educational courses under the UNESCO program in order to teach how countries can apply soft or hard sustainability approaches and how to manage and use data.

- **Public engagement**

In addition to the challenges above, there is a large gap in the present MSP practices, which is the lack of integration of social components of sustainability in planning processes. Therefore, as the MSP process evolves, more social science research is required to better understand the relationship between people's perceptions, attitudes, and values, as well as the roles of various players in decision-making processes [36,42].

- **Climate change and other forms of evolution**

A key cog in re-thinking MSP for the future is that current protocols implement historical as well as predicted data on several techno-economic items, but less importance is provided on the long-term forecast of social and environmental data. Temperature, rainfall, and the probability of extreme weather events as a result of climate change, as well as the migration routes of birds/aquatic animals and other large-scale social phenomena, should be considered in MSP planning. Furthermore, since these plans have a general perspective of at least 20 years, some additional environmental relationships between sea and land

should be analysed and included. For instance, the direct discharge of wastewater or runoff into the sea has the potential to affect aquaculture, fisheries, and tourism. But the need for flexibility in the relocation of activities is not just an environmental matter. On the other hand, by improving technology, new activities might arise. In this vein, better integration between coastal zone management and MSP is recommended in the future, as well as the implementation of procedures to make the planning process more flexible and able to anticipate emerging activities.

- **Scale**

It is worthwhile to note that since the major MSP protocols refer to issues and uses focused on the surface of the sea or on near-shore areas, the items devoted to ecosystem preservation are based on rules and approaches with more focus on surface waters, neglecting the impacts on deep-sea ecosystems (>200 m water depth). This region is less studied despite its significant bio–geo–chemical effects on marine ecosystems [75,76]. In addition, new threats may emerge due to the development of submarine power cables, the active exploitation of resources (for instance, floating wind farms [77]) and industrial-scale deep fishing. In conclusion, more research on techniques to make MSP flexible and to incorporate coastal, marine, and ocean management as a whole into MSP is still needed. Figure 2 summarises the main challenges and solutions in the current MSP practices based on the experiences that have been achieved so far.

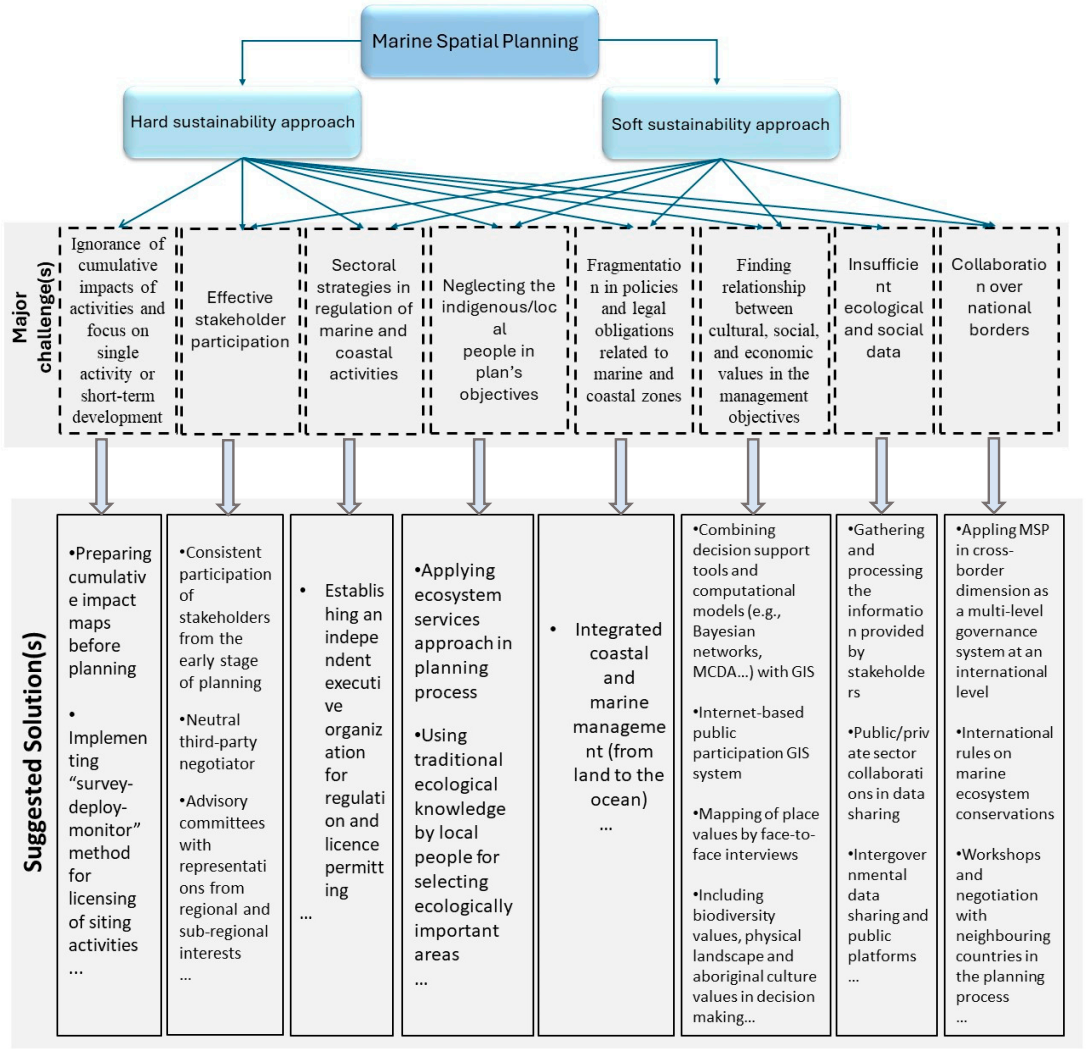

Figure 2. Major challenges and solutions in the hard and soft MSP approaches based on achieved experiences.

4. Conclusions and Recommendations

MSP is widely accepted as an essential tool for improving sustainable management and the development of marine spaces. In the meantime, different international and national Directives on MSP have been in place for more than three decades. However, MSP remains a relatively new and complex process that involves a variety of disciplines and legal contexts, as well as the engagement of various stakeholders. In this work, the study on challenges and good- practices of MSP in some pioneering countries with either soft sustainability or hard sustainability approaches (i.e., Belgium, Netherlands, Norway, Germany, United Kingdom, Australia, and Canada) highlights the following lessons in general:

1. It is essential that the academic and teaching communities provide proactive input into MSP development and implementation; this should be complemented by experiences from practical MSP implementation to inform and refine courses and training. This symbiotic relationship between academia and practical implementation is vital for several reasons. Above all, academic institutions possess valuable theoretical knowledge and research findings that can inform the design and execution of MSP. By leveraging this knowledge, practitioners can develop more robust strategies and approaches for effective MSP implementation. On the other hand, the practical experience gained through real-world MSP initiatives provides invaluable insights and lessons learned that may not be evident in theoretical frameworks alone. This experiential knowledge can help refine and validate academic theories, making them more applicable and relevant to real-world settings. Moreover, integrating practical experience into academic courses and training programs enriches the learning experience for students and professionals alike. It bridges the gap between theory and practice, equipping individuals with the skills, knowledge, and insights needed to navigate the complexities of MSP implementation effectively.
2. Providing MSP expertise and marine spatial planners who can deliver MSP in practice would increase the possibility of dealing successfully with the challenges of MSP. Trained marine spatial planners possess the necessary knowledge and skills to navigate the intricacies of MSP effectively. MSP planners are equipped to analyse marine environments, identify potential conflicts or synergies among different uses, and develop comprehensive spatial plans that balance ecological, social, and economic objectives. In addition, MSP experts and planners could enhance the capacity of decision-makers and stakeholders to make informed choices regarding marine resource management and conservation.
3. Public–private sector collaborations would be useful for sharing expensive geospatial technologies in resource-limited situations. Generally, acquiring and maintaining geospatial data can be financially burdensome, especially for organisations operating in resource-limited settings, such as developing countries or small-scale enterprises. Private sector firms often possess specialised knowledge, skills, and resources in geospatial technology development and application. Collaborating with these entities enables public organisations to leverage the expertise of industry professionals, thereby enhancing their capacity to effectively utilise geospatial tools for decision making and problem solving. In addition, leveraging public–private collaborations allows for the scalability and sustainability of geospatial initiatives. Private sector entities could invest in research and development efforts to enhance the accessibility and affordability of geospatial technologies, along with ensuring the long-term viability of geospatial applications in resource-limited contexts.
4. Permanent education by developing academic degrees on MSP or training courses under the UNESCO program could be an important step for future MSP. Students would gain a deep understanding of the principles, methodologies, and best practices of MSP through structured courses, research opportunities, and practical training. In the meantime, training courses under the auspices of UNESCO or similar international organisations could extend the capacity-building efforts of MSP globally. These courses could be designed to cater to a diverse audience, including government

officials, policymakers, researchers, and practitioners from both developed and developing countries, thereby fostering a more inclusive and collaborative approach to MSP.

More specifically, the key contributions of this study and the lessons from challenges and good practices in the studied countries highlight the following points:

5. Establishing an independent executive organisation can be useful to achieve interconnected agreements between stakeholders and the government. Furthermore, a neutral third-party negotiator could assist in reaching a compromise between the stakeholders. In fact, by operating independently of specific government departments or agencies, an independent executive organisation could prioritise MSP objectives and facilitate collaboration among stakeholders without being influenced by bureaucratic constraints or political agendas. Additionally, such an organisation could enhance transparency, accountability, and legitimacy in MSP processes by ensuring that decisions are based on scientific evidence, stakeholder input, and public participation. On the other hand, since MSP is inherently a complex process involving multiple stakeholders with competing interests, a neutral third-party negotiator could assist stakeholders in overcoming barriers to agreement, such as power imbalances, cultural differences, or different priorities. Moreover, the presence of a neutral negotiator could reduce the risk of deadlock or conflict, thereby expediting decision making and the implementation of MSP.
6. The consistent participation of stakeholders from the early stage of planning is critical for success in MSP. Early engagement allows stakeholders to contribute their insights, concerns, and priorities, which can help identify potential conflicts, opportunities, and synergies among various land and ocean uses. Moreover, by fostering ownership and buy-ins from stakeholders early on, MSP initiatives are more likely to garner support, legitimacy, and commitment throughout their planning and implementation phases. In addition, MSPs should be open to discussing new concepts, goals, and risks to remain impartial, especially in countries where there are different cultural and socio-economic backgrounds among the stakeholders. In this regard, MSP should create opportunities for participation, dialogue, and collaboration among diverse stakeholders, including indigenous communities, fishers, coastal residents, industry representatives, environmental NGOs, and government agencies. By fostering mutual understanding and cooperation among these groups, MSP initiatives could build social capital, enhance social cohesion, and promote collective action for sustainable marine governance.
7. The ecosystem services approach can provide a useful framework for connecting social and natural systems while integrating a wide range of criteria into the valuation process. Generally, ecosystem services refer to the numerous benefits that humans obtain from ecosystems, which range from providing services (e.g., food and water) to regulating services (e.g., climate regulation and flood control), as well as cultural services (e.g., recreation and spiritual enrichment). By adopting the ecosystem services approach, MSP recognises the intricate connections between ecological processes and human well-being, thereby fostering a holistic understanding of marine ecosystems and their importance to society. In addition, the ecosystem services approach expands the scope of valuation to social, cultural, and ecological dimensions. This broader perspective allows MSP practitioners to consider a wide range of criteria, including biodiversity conservation, habitat protection, cultural heritage preservation, and social equity in decision-making processes.
8. The experience in Australia demonstrates that adaptive MSP processes can achieve their goals in ecosystem conservation through the continued monitoring and evaluation of the ecosystem and the subsequent modification of plans according to changing circumstances. Ongoing monitoring and evaluation enable MSP practitioners to track changes in ecosystem health and functioning, identify emerging threats or vulnerabilities, and evaluate the effectiveness of management interventions. Since marine

ecosystems are dynamic and subject to various natural and anthropogenic pressures, MSP plans should be adaptive to accommodate uncertainties. This may involve incorporating buffer zones, setting aside areas for ecological reserves or MPAs, establishing adaptive management strategies, or implementing zoning schemes that can be adjusted over time in response to new information or changing priorities.

9. Internet-based public participation GIS systems could be a useful technique for incorporating social data in planning processes as well as predicting possible conflicts of use. Web-based mapping tools with user-friendly interfaces enable diverse stakeholders, including local communities, fishermen, recreational users, environmental groups, and government agencies, to actively participate in data collection, mapping, and decision-making processes. Internet-based public participation GIS systems can facilitate the exchange of knowledge, perspectives, and preferences among stakeholders through online surveys, mapping exercises, and interactive forums. Additionally, by overlaying social datasets onto spatial maps, stakeholders can visualise and analyse the distribution of human activities, interests, and concerns within marine areas. On the other hand, MSP practitioners can identify potential conflict hotspots and prioritise areas for further analysis or intervention by crowdsourcing information from stakeholders and mapping areas of overlapping or incompatible activities.

Aside from the lessons learnt thus far in MSP, other forthcoming challenges may include integrating the effects of climate change into the planning process and understanding how it might affect distribution and space allocation in different activities in the sea in the long-term, providing sustainable financial support for the establishment of research on MSP especially at an international level, extending MSP beyond the EEZ boundary, and ensuring effective cooperation between countries; more discussion on the future challenges of MSP can be found in [12,24,78,79].

It is recommended that international cooperation should be further developed to secure (1) an effective data-sharing experience, (2) a platform for joint legislation frameworks, and (3) properly considering the connectivity of habitats and integrity of marine ecosystems beyond national waters in the planning process. As well as this, as new sectors and industries emerge (e.g., marine renewable energies [80,81]), it is suggested to explore how they might shape MSP in the future. Finally, it is important to determine how successfully MSP can be monitored or measured since priority and planning approaches differ from country to country. It is also noteworthy to mention that the present study is based on the available reports/publications from scientific databases, and there might be scattered reports or statements about MSP challenges in the studied countries that were not included in this study due to the limited access of the authors to many of the relevant documents in the private sectors or in governmental sections. Although there have been considerable efforts for intergovernmental data sharing so far (e.g., the ocean decade website by UNESCO or MSPglobal and MSPforum by IOC-UNESCO and the European Commission), it is recommended that data sharing and public platforms be improved to share not only experiences and knowledge on MSP but also challenges and solutions in a more readily accessible and systematic manner.

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