sustainability

Review

A Review of the Sustainable Siting of Offshore Wind Farms

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Abstract: The continued technical and economic development of offshore wind farms needs to match their sustainable siting transparently and fairly. Aiming to assess existing methodologies widely used in the field of OWFs spatial planning, as well as to identify the proposed enhancements for the improvement of such methods, this study examines 80 peer-reviewed papers over the past eight years. The analysis encompasses articles from 34 scientific journals, with a notable concentration in the journals Renewable Energy, Renewable and Sustainable Energy Reviews, and Energies, and it sheds light on geographical distribution, journal classification, funding sources, and the various methodological approaches. Most of the studies were conducted in Turkey, China, and Greece; half of the surveyed papers utilize multi-criteria decision-making approaches, predominantly addressing bottom-fixed technologies for offshore wind farms, which currently dominate the field. The 80 papers are categorized into five methodological domains: Marine Spatial Planning, Feasibility Analysis, Probabilistic Methods, Meteorological Data, and Multi-Criteria Decision Making. One hundred and seventy criteria were identified and condensed into a final set of 41 critical criteria. This article provided an overview of the site selection process and the most crucial findings and recommendations.

Keywords: offshore wind farms; site selection; multi-criteria methodologies; sustainable siting

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1. Introduction

Currently, offshore wind energy plays a vital role in the global energy market. In accordance with the latest reports, over 380 GW of offshore wind capacity is expected to be incorporated in the coming ten years, elevating the cumulative capacity of offshore wind energy to 447 GW by the end of 2032 [1]. In the next ten years, over 380 GW of offshore wind capacity will be added across 32 markets. According to Figure 1, the 8.8 GW of new offshore wind installations bring the global offshore wind power capacity to 64.3 GW, representing 16% growth year-over-year [1].

The wind energy sector in Europe is amongst the leading energy sources, with an installed capacity of 234 GW in 2023. The offshore power sector has gained importance in recent years, with the total capacity of offshore in Europe (E-27) reaching 20.5 GW in 2023 and more than 2 GW added during 2023 [2]. According to the European Commission, offshore capacity is expected to continue to increase within the next few decades, which will lead to an increase from the current level of offshore installed capacity [3,4]. Several reforms and measures are being taken, including an increase in the EU's offshore renewable energy target for 2030 to 111 GW from the 61 GW outlined in the 2020 EU Offshore Renewable Energy Strategy. Out of the 61 GW targeted for renewable energy, 60 GW were for offshore wind. Additionally, the target for 2050 has been increased to approximately 317 GW [5].

Efforts are made by governments and organizations around the world to reduce greenhouse gases (GHGs) that contribute to climate change. Mitigation and management strategies must be adopted on a basis that is accepted by all since anthropogenic climate change poses threats to the planet and the entire economy. To address the looming threat of global warming, many nations have taken measures to reduce greenhouse gas emissions, including offshore wind energy, which is an increasingly feasible alternative to meet these goals [6].

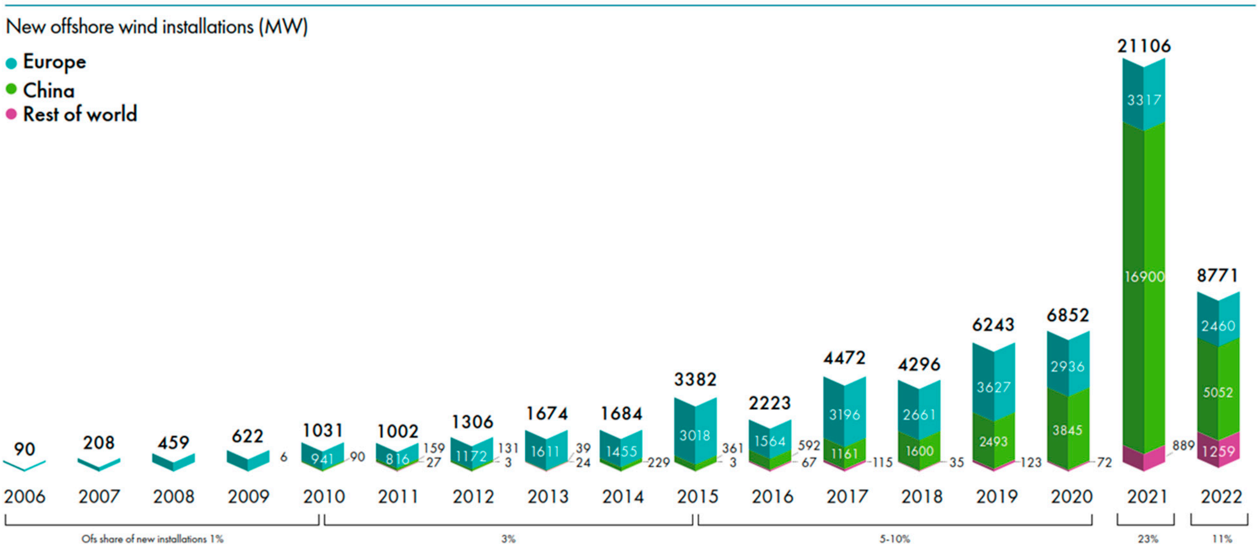

Figure 1. New offshore wind installations (MW) [1].

Offshore wind farms (OWFs) have several advantages over their onshore counterparts, including the following [7]:

- Marine areas have a more robust and consistent wind flow due to the absence of physical obstacles, such as mountains or tall buildings that can hinder wind flow.
- There are generally greater rated capacities for offshore wind turbines than onshore wind turbines, leading to higher energy production.
- It has been found that OWFs are more likely to alleviate land-use conflicts than onshore ones, because they are generally located far from residential areas.
- The development of regional and national policies can take advantage of this valuable but underutilized resource.
- Due to their ability to withstand extreme weather conditions, they are an effective and reliable source of energy.

Many studies have been conducted that concern OWFs regarding technical requirements [8–10] environmental impact [11–15] and other related topics [16]. However, only a limited number of reviews examine the critical factor of the site selection of an OWF. These studies mainly concentrate on the use of Geographic Information System (GIS) [6], or/and the use of decision-making (DM) methodologies [17,18].

Therefore, it is rare to find a review approach that collects and assesses a considerable number of papers concerning general methodologies for the siting of an OWF. This review paper aims to address a gap in the global literature by examining and consolidating best practices related to OWF site selection. In conclusion, this review paper:

- Assesses and analyses methodologies regarding the siting of OWFs.
- Gathers and describes criteria used in the literature
- Summarizes essential conclusions and recommendations on the critical topic of the site selection process.

This paper comprises four sections: Section 1, the introduction addresses the significance of renewable energy for the planet and focuses primarily on offshore wind power as a source of renewable energy; Section 2 describes the review process of the bibliography; in Section 3, the results of the analysis are presented according to the journal, geographic area, type of structure, methodology, and criteria used by each paper and discussed; Section 4 summarizes the research and makes recommendations for future studies.

2. Materials and Methods

2.1. Review Planning and Question Formulation

This study used a systematic review tailored to the specific research questions, resources available, and the required level of detail. This method is widely accepted as the benchmark for evidence synthesis in the research and development sector, enhancing its thoroughness. A comprehensive review of all relevant studies was conducted, including applying selection criteria and extracting essential outcomes.

An analysis of previous studies provided insight into key trends that would improve the sustainable siting of OWFs in future practices. More specifically, an overview of analyses in OWF site selection studies was developed based on search terms that were representative of the review. Different technologies like floating, as well as fixed, OWFs were also examined in the review process.

In this review, three a priori questions were addressed: (1) what methods are most commonly used for securing an optimum OWF site; (2) which methods are most popular, and; (3) what suggestions might be made for the improvement of this approach?

A systematic literature review was conducted using the search terms «OWF site selection» and «OWF siting».

A systematic review was conducted in November and December of 2023 on two databases: Scopus (Elsevier) and ScienceDirect (Elsevier). The terms «Offshore Wind Farm site selection» and «Offshore Wind Farm siting» were searched in the advanced research option in the field of title, abstract, and keywords. The results in ScienceDirect were about 276 articles (Offshore Wind Farm siting) and 59 articles (Offshore Wind Farm site selection), whereas in Scopus 108 articles (Offshore Wind Farm siting) and 240 articles (Offshore Wind Farm site selection).

In the first phase, the found papers followed a clustering based on their relevance to the terms of the search, which had to appear in the title, abstract, and keywords. Following that, a further in-depth examination of the abstract and methodology of each paper was carried out to determine whether it was relevant to the topic studied. Based on the methodology described above, 80 papers were finally selected under the current analysis. In both databases evaluated, there were duplicate papers, so they were excluded from the analysis. In addition, relevant review papers were excluded from our analysis since they focused on research papers and case studies in order to assess and draw conclusions regarding the siting procedures of OWFs. Review papers are excluded because they contain circular secondary sources of data rather than detailed experimental or observational data, methodologies, and analyses that contribute to the overall understanding of the field. The review process is depicted in Figure 2.

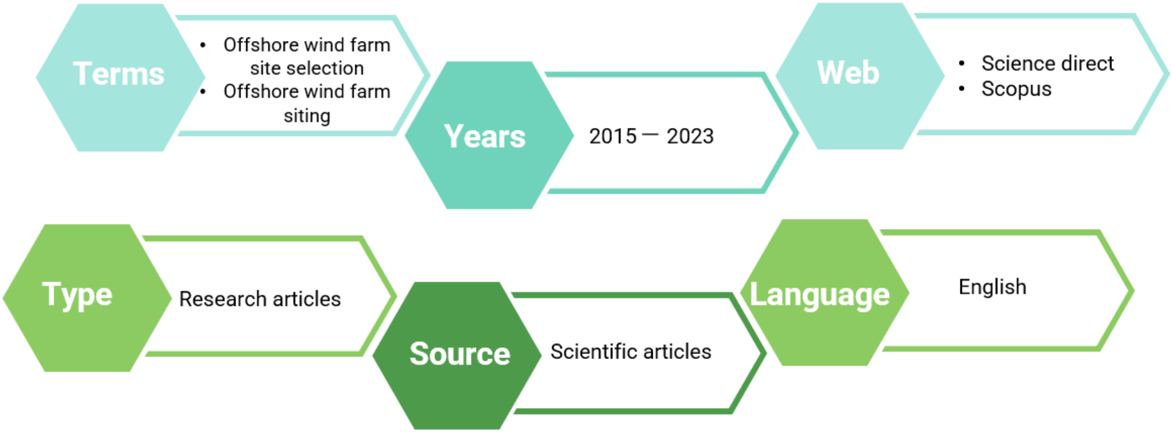

Figure 2. Overview of the review process.

The selected time range was set for the period after 2015 until today to ensure the newest and freshest approaches in this sector. After that, the criterion of the type of articles had to be taken under serious consideration. During the search, only peer-reviewed publications were considered; conference proceedings and grey literature were not included for original and scientific reasons. The fact that such investigations were unpublished and proprietary helped mitigate any potential bias that might have existed.

2.2. Review Analysis and Structure of Results

The review paper analyses the papers according to the following specific criteria to provide a comprehensive understanding of the research landscape in the field of offshore wind farms:

1. Keywords Analysis: Analyzing keywords helps identify common themes, trends, and research priorities within the field. It allows researchers to gain insights into the main focus areas and topics of interest in offshore wind farm studies.
2. Allocation per Journal: Examining the distribution of papers across different journals provides insights into the publication outlets favored by researchers in the field. It helps assess the diversity of scholarly platforms, the prominence of specific journals, and the dissemination of research within the academic community.
3. Allocation per Geographic Area: Understanding the geographic distribution of research helps identify regional priorities, challenges, and opportunities in offshore wind farm development. It allows researchers to assess the applicability of findings across different geographical contexts and tailor solutions to specific regional needs.
4. Allocation per Foundation Type: Different types of foundations, such as fixed-bottom or floating platforms, have unique design considerations, costs, and environmental impacts. Analysing the allocation of research per foundation type helps identify trends in technological advancements, design preferences, and the evolution of offshore wind farm infrastructure.
5. Allocation per Methodology Adopted: Examining the methodologies adopted in research papers provides insights into the approaches used to address research questions and challenges in offshore wind farm studies. It helps assess the rigor, reliability, and diversity of research methodologies applied within the field.
6. Criteria Used: Identifying the criteria used in research papers helps understand the factors considered in decision-making processes, project evaluations, and impact assessments related to offshore wind farm development. It allows researchers to assess the comprehensiveness and relevance of criteria used in different studies.
7. Experts Included: Evaluating the involvement of experts in research papers sheds light on the level of expertise, collaboration, and interdisciplinary approaches within the field. It helps assess the credibility, robustness, and applicability of research findings and methodologies.

3. Results and Discussion

By analyzing papers based on these criteria, the review paper aims to synthesise existing knowledge, identify research gaps, highlight methodological approaches, and contribute to the advancement of understanding and practices in offshore wind farm development and management. Table 1 summarizes the 80 reviewed papers by Study Area, Type of Structure, Journal Name, Year of Publication, Number of Experts, Use of GIS, and relevant references. A further analysis of the results is presented in the following substructures from Sections 3.1–3.7.

Table 1. Reviewed papers.

A/A	Study Area/Country	Type of Structure (Fixed/Floating)	Journal Name	Year of Publication	Number of Experts	Use of GIS	Source
1	UK	bottom-fixed	Energies	2018	13	✓	[19]
2	Aegean Sea/Greece	Floating	International Journal of Energy	2019	no	✓	[20]
3	Cyclades (Greece) and İzmir (Turkey)	bottom-fixed	Environmental Monitoring and Assessment	2020	26	✓	[21]
4	Canary Islands (Spain)	Floating	Energies	2021	5	✓	[22]
5	Lake Erie, northern Ohio, USA	bottom-fixed	Renewable and Sustainable Energy Reviews	2015	21	✓	[23]
6	China	Both	Ocean and Coastal Management	2020	n/d	no	[24]
7	Eastern China Sea, China	bottom-fixed	Ocean Engineering	2018	5	no	[25]
8	Crete, Greece	bottom-fixed	Energy	2022	33	✓	[7]
9	local (Basque Country) and regional (Northeast Atlantic and Western Mediterranean)	Both	Science of the Total Environment	2019	n/d	✓	[26]
10	UK	n/d	Annals of Operations Research	2016	no	no	[27]
11	China	n/d	Engineering Optimization	2017	8	✓	[28]
12	UK	Both	Renewable Energy	2016	yes, n/d	✓	[29]
13	Egypt	n/d	Journal of Cleaner Production	2021	n/d	no	[30]
14	Atlantic continental European coastline Portugal, Spain and France	Floating	Renewable and Sustainable Energy Reviews	2020	no	✓	[31]
15	Eastern China Sea, China	n/d	Renewable Energy	2021	4	no	[32]
16	Persian Gulf, Iran.	Both	Ocean and Coastal Management	2015	5	no	[33]

Table 1. *Cont.*

A/A	Study Area/Country	Type of Structure (Fixed/Floating)	Journal Name	Year of Publication	Number of Experts	Use of GIS	Source
17	Atlantic coastal areas of Portugal, Spain, and France	Floating	Renewable Energy	2022	5	✓	[34]
18	Samothraki island, Greece	Both	Renewable Energy	2021	no	✓	[35]
19	China	Both	Remote Sensing	2019	no	no	[36]
20	n/d	bottom-fixed	Journal of Environmental Management	2020	34	no	[37]
21	Brazil	Both	Renewable and Sustainable Energy Reviews	2021	n/d	✓	[38]
22	Taiwan	Both	Sustainable Energy Technologies and Assessments	2021	7	no	[39]
23	n/d	Both	Energy Policy	2018	25	no	[40]
24	UK	floating	Sustainable Energy Technologies and Assessments	2021	9	no	[41]
25	Brazilian coast, Brazil	bottom-fixed	Sustainable Energy Technologies and Assessments	2021	no	✓	[42]
26	Turkey	bottom-fixed	Energy Strategy Reviews	2019	no	no	[43]
27	Bozcaada, Turkey Aegean Sea, Greece	bottom-fixed	Renewable and Sustainable Energy Reviews	2018	no	no	[44]
28	Gulf of Maine. USA	Floating	Renewable Energy	2022	3	✓	[45]
29	Hong Kong bay	bottom-fixed	Annals of GIS	2019	no	✓	[46]
30	Bozcada, Aegean Sea, Turkey	bottom-fixed	International Journal of Exergy	2021	no	✓	[47]
31	Morocco, North Africa	Both	Energy Conversion and Management	2021	n/d	✓	[48]
32	Greece	Both	Renewable and Sustainable Energy Reviews	2017	no	✓	[49]
33	n/d	Both	European Water	2017	no	✓	[50]
34	Irish Sea	Both	Quarterly Journal of Engineering Geology and Hydrogeology	2020	no	✓	[51]

Table 1. *Cont.*

A/A	Study Area/Country	Type of Structure (Fixed/Floating)	Journal Name	Year of Publication	Number of Experts	Use of GIS	Source
35	Ireland	bottom-fixed	Energy	2020	n/d	✓	[52]
36	Canary Islands	Both	Renewable and Sustainable Energy Reviews	2021	n/d	✓	[53]
37	Shandong Province, China	n/d	Journal of Cleaner Production	2018	15	no	[54]
38	Galician area (North-West of Spain)	floating	Marine Policy	2020	no	✓	[55]
39	Egypt	bottom-fixed	Renewable Energy	2018	no	✓	[56]
40	Shandong Province, China	n/d	Energy	2020	yes, n/d	no	[57]
41	Esthonia, Latvia, Lithuania, Baltic States	bottom-fixed	Energy Policy	2017	n/d	✓	[58]
42	Atlantic-facing coasts of Europe	floating	Renewable Energy	2016	no	✓	[59]
43	Mediterranean Basin	floating	Energy Conversion and Management	2021	no	no	[60]
44	South Africa	Both	Journal of Energy in Southern Africa	2020	no	✓	[61]
45	Taiwan	bottom-fixed	Ocean and Coastal Management	2017	n/d	no	[62]
46	Jeju Island, South Korea	bottom-fixed	Renewable Energy	2016	no	✓	[63]
47	Turkey's coastal area	n/d	Applied Soft Computing	2021	4	no	[64]
48	Gulf of Thailand	bottom-fixed	Renewable Energy	2015	no	no	[65]
49	China	bottom-fixed	Ocean and Coastal Management	2018	no	✓	[66]
50	China	bottom-fixed	Energy Conversion and Management	2019	7	no	[67]
51	Atlantic ocean	floating	Energy Conversion and Management	2022	no	no	[68]
52	Portuguese coast	Both	Renewable Energy	2019	no	✓	[69]
53	southeast coast of Brazil	bottom-fixed	Energy	2019	no	no	[70]

Table 1. *Cont.*

A/A	Study Area/Country	Type of Structure (Fixed/Floating)	Journal Name	Year of Publication	Number of Experts	Use of GIS	Source
54	United Kingdom	n/d	Annals of Operations Research	2018	no	no	[71]
55	Caspian Sea, Iran and Turkey The Caspian Sea is the largest lake in the world. This sea is surrounded by five countries, such as Iran, Russia, Azerbaijan, Turkmenistan, and Kazakhstan.	bottom-fixed	Wind Engineering	2019	no	no	[72]
56	Greece	Both	Energies	2018	yes, n/d	✓	[73]
57	southwest coast of South Korea	bottom-fixed	Renewable Energy	2018	no	✓	[74]
58	Canary islands	Both	Energy	2018	no	✓	[75]
59	Greece	Both	Sustainability	2020	7	✓	[76]
60	China	n/d	Energy Conversion and Management	2016	yes, n/d	no	[77]
61	coastal part of Turkey, Turkey's seas	bottom-fixed	Earth Science Informatics	2021	no	✓	[78]
62	Greece	bottom-fixed	Sustainability	2018	no	✓	[79]
63	Chania, Crete, Greece	bottom-fixed	Renewable Energy	2017	no	✓	[80]
64	Turkey	bottom-fixed	Energy Strategy Reviews	2018	no	no	[81]
65	Irish Waters, Ireland	Both	Energies	2019	no	no	[82]
66	Turkey	bottom-fixed	Sustainable Energy Technologies and Assessments	2019	yes, n/d	no	[83]
67	Bass Strait, Australia	Both	Journal of Cleaner Production	2021	no	✓	[84]
68	off the coast of New Jersey, USA	Both	Engineering Applications of Artificial Intelligence	2021	yes, n/d	no	[85]
69	Poland	bottom-fixed	Applied Energy	2021	yes, n/d	no	[86]
70	Poland	bottom-fixed	Energies	2017	no	no	[87]

Table 1. *Cont.*

A/A	Study Area/Country	Type of Structure (Fixed/Floating)	Journal Name	Year of Publication	Number of Experts	Use of GIS	Source
71	Mediterranean Basin	Floating	Renewable Energy	2024	no	no	[88]
72	Turkey, Iskenderun Bay	Both	Energy for Sustainable Development	2023	4	✓	[89]
73	Turkey	n/d	Journal of Cleaner Production	2024	4	✓	[90]
74	Spain	Both	Science of The Total Environment	2024	no	no	[91]
75	Australia	Both	Ocean and Coastal Management	2022	9	✓	[92]
76	South Korea	Bottom-fixed	Energy Reports	2023	no	no	[93]
77	Norway	Both	Wind Energy	2023	no	no	[94]
78	Colombian Caribbean Coast	Both	Journal of Energy Economics and Polic	2023	10	no	[95]
79	located in French waters of the Bay of Biscay (northeastern Atlantic)	n/d	Journal of Environmental Management	2023	yes, n/d	no	[96]
80	Greece, central Aegean Sea	Floating	Energies	2023	yes, n/d	✓	[97]

3.1. Keywords Analysis

VosViewer was used to identify the occurrences (keyword frequency in documents) of all kinds of keywords appearing in the 80 papers under investigation. For that reason, 80 Scopus files were created and inserted into the software. There were 866 keywords (Author and Index keywords), from which 59 met the threshold of 5 occurrences, while by selecting 10 occurrences, as demonstrated in the above figure, only 23 keywords met the threshold. It is notable that in Figure 3, 19 keywords out of the 23 remained, which is a result of cropping identical keywords, i.e., "OWF" and "wind farm", were unselected, as "OWFs" had more occurrences and remained in the figure.

Accordingly, the size of the label and circle of an item is determined by its weight; this means that if an item has a high weight, its label and circle will be larger, for example, "OWFs", "site selection", "decision making" have a high weight. There are three clusters (blue, green, and red) determined by the colour of an item. In addition, the lines between the items indicate links between them (Figure 3). As shown in the visualization, the distance between two items approximately indicates the relationship between the keywords (in terms of both being referred to in the same publication). The strong density of these items in all different regions of the map shows, more or less, well-developed research activities. There is a connection between two keywords that strengthens the closer they are located to each other; for example, multicriteria analysis is related to both sensitivity analysis and spatial planning (Figure 4), though it is closer to the last one owing to its proximity. In Table 2, the words' occurrences and link strength are demonstrated from those of high importance to the least important keywords.

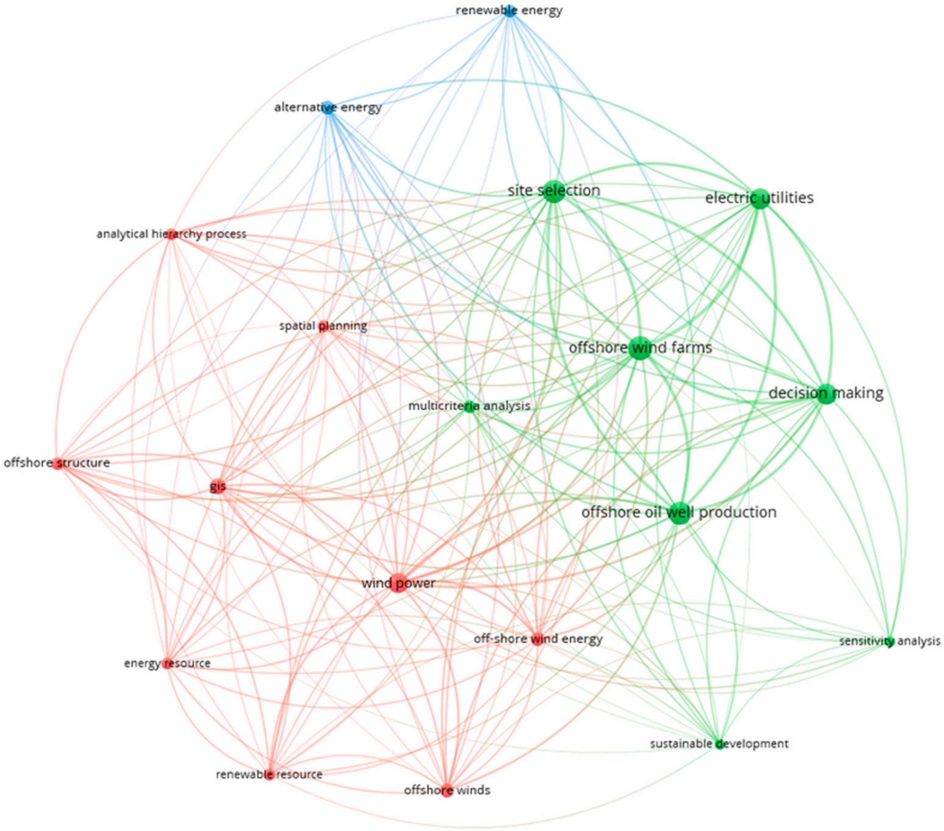

Figure 3. VosViewer Network visualization: Author and Index keywords of 10 occurrences and more in 80 papers.

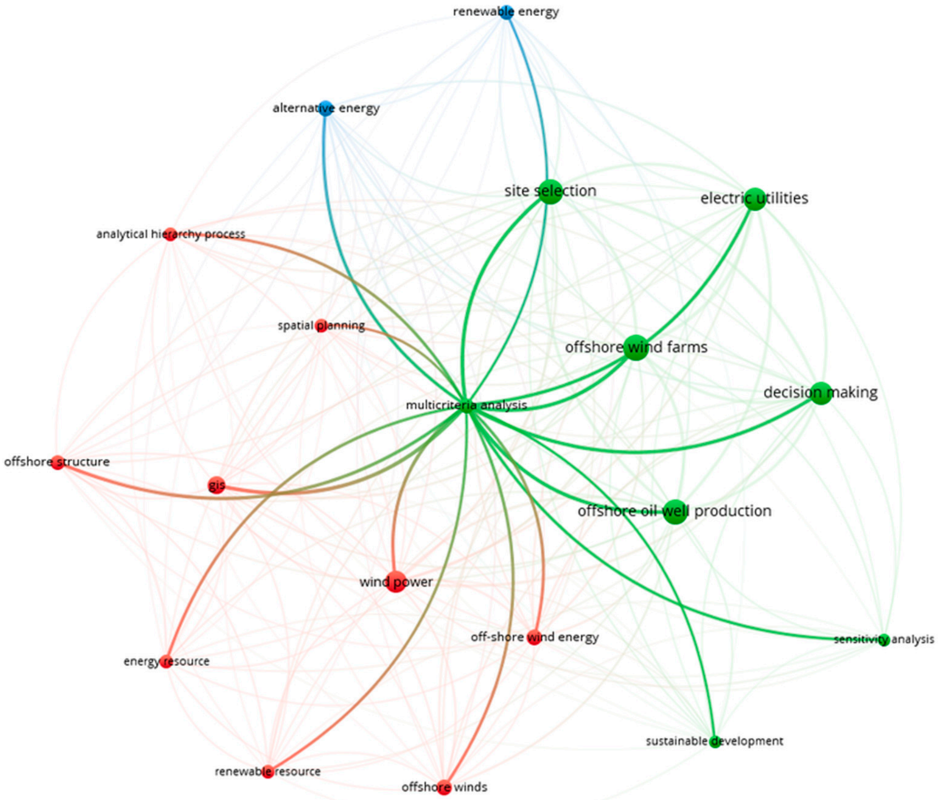

Figure 4. VosViewer network visualization: all links to "multicriteria analysis" keyword.

Table 2. Keywords with more than 10 occurrences in a descended hierarchy, demonstrated with the indicators: (i) number of occurrences and (ii) total link strengths.

High Importance	Keyword	Occurrences	Total Link Strength
	OWFs	50	331
	Offshore oil well production	46	298
	Site selection	44	280
	Electric utilities	39	273
	Decision making	39	264
	Wind power	33	235
	GIS	22	161
	Offshore wind energy	17	129
	Offshore winds	17	117
	Alternative energy	16	134
	Multicriteria analysis	15	119
	Offshore structure	15	113
	Renewable energy	15	95
	Renewable resource	12	95
	Analytical hierarchy process	12	80
	Energy resource	11	89
	Spatial planning	11	76
	Sustainable development	10	70
Low importance	Sensitivity analysis	10	69

3.2. Allocation per Journal

The allocation per journal is part of a generic bibliometric analysis and sheds light on the journals that are dedicated to the subject of OWFs, thereby facilitating future contributors' state-of-the-art analyses, while at the same time enabling us to verify the outcomes of our analysis. Additionally, experts in the field could make use of it in terms of publishing their scientific papers.

Between 2015 and 2023, 34 different scientific journals published the reviewed articles (Table 1). Six journals accounted for half (50%) of these publications. The highest percentage of the reviewed papers was in Renewable Energy with 16% (13 articles), Renewable and Sustainable Energy Reviews and Energies each with 8% (6 articles), and then Energy, Ocean and Coastal Management and Energy Conversion and Management each with 6% (5 articles) (Figure 5). The diverse distribution across various journals suggests a growing complexity in the offshore wind market. It also reflects a multi-disciplinary interest in this emerging technology, indicating the concentration of many scientists on studying it.

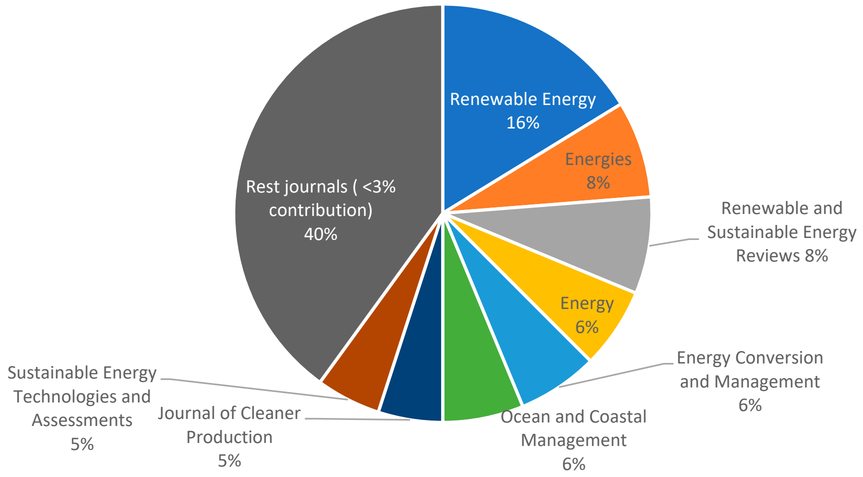

Figure 5. Paper allocation per journal.

3.3. Allocation per Geographic Area

The studies were distributed to 24 different study geographical areas (Table 1). The highest percentage was found in Turkey at 14% (12 studies), then China followed at 13% (11 studies) and Greece at 12% (10 studies). UK and Atlantic coastal areas, including Portugal, Spain, and France, follow with percentages of 6% (5 studies) (Figure 6). As evidenced by the results showing that they invest and conduct worthy research in this sector, the East (China) has established itself as a pioneer in the offshore marine energy industry. Based on the geographic analysis, the countries with sea areas that have not developed Offshore Wind installations do research in order to be ready to develop when the conditions are favourable (economic status, studies, legislation).

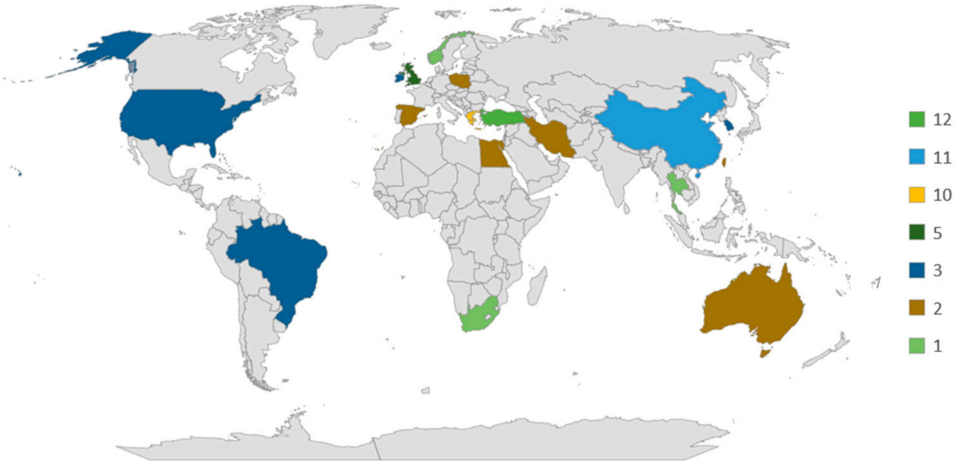

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Figure 6. Allocation of papers per study area.

3.4. Allocation per Foundation Type

The majority of the examined studies focus on bottom-fixed technology, which is currently the most prevalent and commonly utilized. Specifically, 37% (30 studies out of 80) analyse the site selection for exclusively bottom-fixed OWFs (Table 1). In contrast, a limited percentage of 15% (12 studies) investigate the site selection process solely for the emerging technology of floating OWFs. Notably, 34% (27 studies) delve into both bottom-fixed and floating technologies. Lastly, a small percentage of 14% (11 studies) do not specify a particular type of foundation in their examination.

Based on the criterion of water depth, it can be concluded that when the criterion is limited to 50–60 m, the technology is bottom-fixed, when it ranges from 50–1000 m, it is floating, and when it varies from 0–1000 m, it refers to both types of structures [29]. The papers in which the range of water depth is not defined are classified as n/d, but this is not a limiting factor since both types of technologies might be considered.

3.5. Allocation per Methodology Adopted

In the 80 papers that were reviewed (Table 1), the methodologies were categorized into five categories: MCDM, Feasibility analysis, Meteorological data, Marine Spatial Planning, and Probabilistic methods; the remaining papers that did not correspond to some of the categories above were categorized under the sixth category, because they utilized other methods or a combination of them. The six categories and the relevant percentages are depicted in Figure 7 and Table S3.

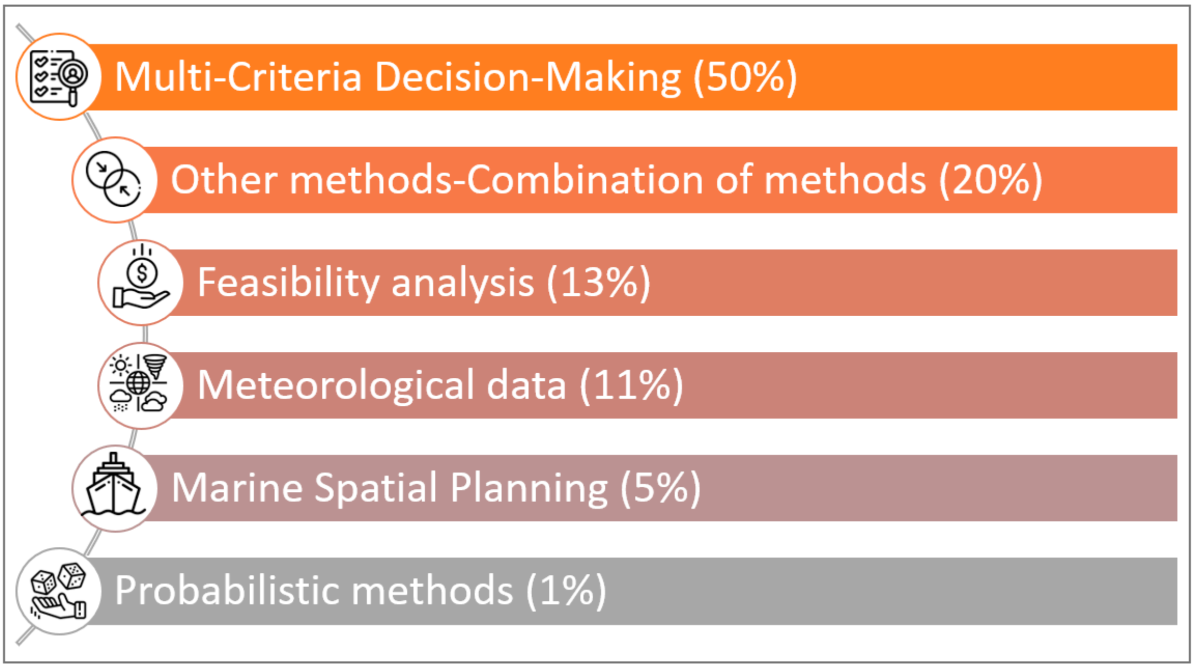

Figure 7. Methodology used by the reviewed papers.

Furthermore, in Figure 8, all the methodologies used by the reviewed papers are depicted, including all the MCDM methodologies that were found in the review process. The dashed lines in Figure 8 mean that one or more methodologies are combined. A brief description section about every MCDM methodology is summarised below (a-l). In the analysis, 43 out of 80 papers use the geospatial analysis in conjunction with the GIS tool, indicating that the GIS is an appropriate and handy tool for the DM of optimal solutions for the development of an OWF. The reason for this is that GIS is capable of integrating an extensive collection of geospatial data and information and of developing algorithms that can lead to the desired outcomes (Table S3).

- In 40 of the 80 papers (50%) reviewed, MCDM methods were used (Table S4) in order to determine which sites would be more appropriate for developing OWFs (Table S3). As a result, it is verified from the global literature that these kinds of methods are the most popular for approximating multi-parameter problems, such as the optimal location of an OWF (Figure 9).
- In 10 of the 80 papers (13%) that were reviewed, feasibility and technoeconomic analyses were used as a tool to identify which sites would be the most appropriate for OWF deployment in order to determine their feasibility.
- Nine out of the eight papers (11%) reviewed used meteorological data and models to determine which sites would be most suitable for developing OWFs.
- A total of 4 out of 80 papers (5%) utilize the marine spatial planning methodology to identify potential OWF development sites.
- In regards to the probabilistic method, it appears that it is not very frequently used for this purpose, since only one study has used it to assess Offshore Wind development sites.
- The remaining 16 papers (20%) use a method that is entirely different from the one described above or a combination of both.

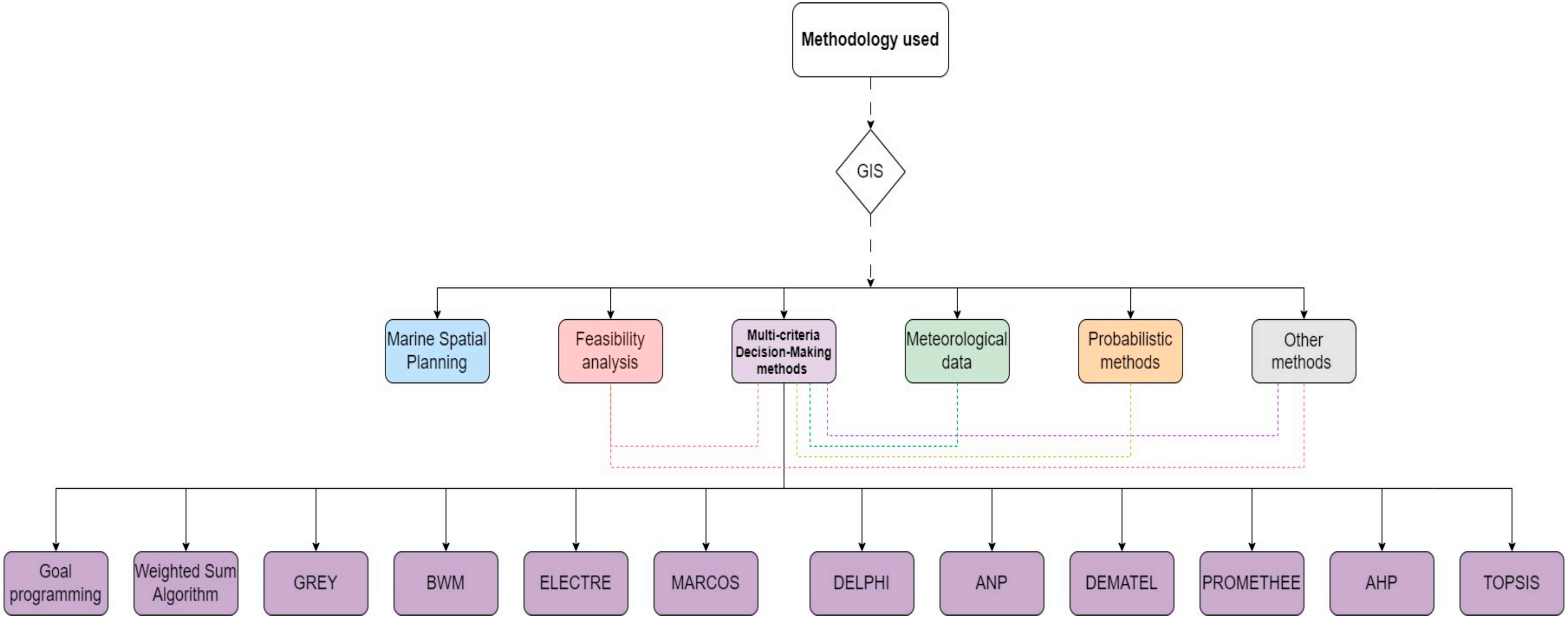

Figure 8. Methodologies used per paper and their combination.

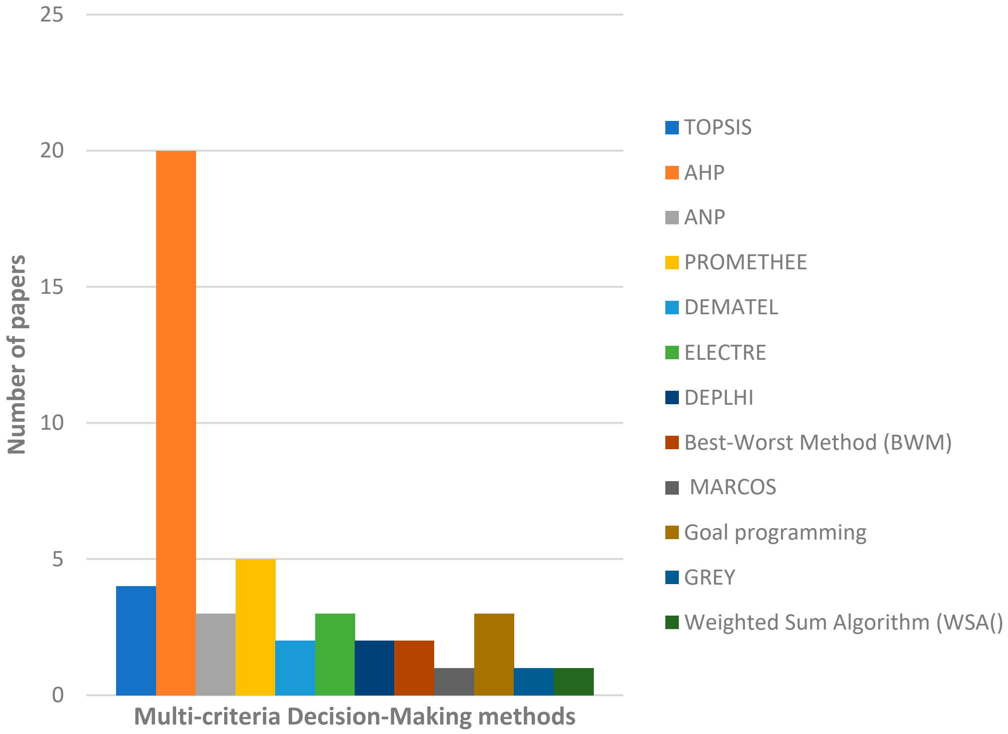

Figure 9. Number of papers used MCDM.

An Overview of the Most Commonly Used DM Tools

(a) Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) assume that every criterion increases or decreases in utility monotonically, thus making it easier to identify positive and negative ideal solutions. In order to evaluate the distance between the alternatives and the ideal solution, Euclidean distance is proposed. By comparing the relative distances between the alternatives, it is possible to determine their preference order. A TOPSIS procedure begins by converting the various criteria dimensions into non-dimensional criteria. Accordingly, the chosen alternative should be the closest to the positive ideal solution and the furthest from the negative ideal solution [98].

(b) Analytic Hierarchy Process (AHP) involves decomposing complex decision problems into a hierarchy of criteria, sub-criteria, and alternatives and then making pairwise comparisons among these elements to determine their relative significance. The process involves normalizing the comparisons, calculating priority vectors for each level of the hierarchy, and checking the consistency of the priorities. AHP has a wide range of applications in business and management, engineering, healthcare, and environmental DM. It can be used to compare and evaluate different options, prioritize resources, allocate funding, and make strategic decisions. AHP is helpful in situations where decision-makers need to consider multiple criteria (MC) and make trade-offs between conflicting objectives [99].

(c) Analytic network process (ANP) is a development of AHP. ANP is designed to identify and resolve decision problems that involve interdependencies and feedback loops among criteria and alternatives, which cannot be captured by a simple hierarchy. ANP is the process of decomposing a decision problem into a network of clusters and elements and determining their relative importance by comparing them pairwise. The process involves normalizing the comparisons, calculating priority vectors for each level of the network, and checking the consistency of the priorities. It can be used to evaluate complex systems, prioritize resources, allocate funding, and make strategic decisions that take into account the interdependencies and feedback loops among criteria and alternatives. ANP is advantageous in situations where decision-makers need to consider MC and their interactions and make trade-offs between conflicting objectives in a complex environment [100].

(d) Preference Ranking Organization METHod for Enrichment Evaluation (PROMETHEE) ranks alternatives according to certain criteria. Using priority functions, it determines the degree of preference or indifference between each alternative and the others based on each criterion used to break down the decision problem. PROMETHEE then aggregates the preferences for each alternative to generate a ranking of the alternatives. The method also provides sensitivity analysis to evaluate the robustness of the ranking results. It can be used to evaluate and rank alternatives based on MC, considering the preferences and indifference of decision-makers towards each criterion. PROMETHEE proves valuable in scenarios where decision-makers need to make choices between alternatives that have different strengths and weaknesses based on MC [101].

(e) Decision Making Trial and Evaluation Laboratory (DEMATEL) is used for analysing the cause-and-effect relationships among a set of criteria in a complex DM problem. It involves breaking down the decision problem into a set of criteria and sub-criteria and then using the DEMATEL method to construct a directed graph representing the relationships among these criteria. The method allows decision-makers to identify the driving factors and critical issues that are most important in the DM process. It also provides a way to determine the relative importance per criterion and sub-criterion by calculating its degree of influence and dependence in the DM process. It can be used to support DM processes by helping decision-makers identify the most critical issues and factors that should be considered in a decision problem, as well as to weigh the importance of different criteria in a structured and transparent manner [102].

(f) ELimination and Choice Expressing Reality (ELECTRE) method involves comparing multiple alternatives based on a set of criteria and ranking them in order of preference. The proposed model, called the Intuitionistic Fuzzy ELECTRE (IF-ELECTRE), uses IFS to represent the criteria and alternatives and incorporates a decision matrix to calculate the outranking degrees of the alternatives. IF-ELECTRE method involves several steps, including the construction of a preference relation matrix based on the IFS, the calculation of the net flow values for each alternative, and the determination of the final ranking using a weighting scheme. In circumstances where criteria and alternatives are uncertain or imprecise, the IF-ELECTRE model provides an operative framework for decision-makers to evaluate alternatives and make informed judgments [103].

(g) The term 'Delphi method' originated from the Oracle of Delphi in ancient Greece, who was consulted regarding issues ranging from personal matters to public policy. Experts can communicate easily using electronic means through the Delphi method and their responses are anonymous, which allows them to state their preferences without being influenced by others. Alternatively, expert judgment can be helpful when there is no scientific evidence or, if there is, it is contradictory. The opinions of several experts may be more reliable than those of one expert in a situation such as this [40]. A Delphi survey consists of: (a) the subject of study must be identified and explained, as well as a questionnaire to be prepared; (ii) the panel of experts to be consulted must be identified; and (c) the survey should be sorted out and conducted, usually in two or more rounds. An essential aspect of the method is the iteration of rounds to identify convergences or divergences of views, although consensus is typically sought at some point. The absence of consensus often leads to thought-provoking and vital discussions.

(h) The Best-Worst Method (BWM) involves ranking a set of alternatives based on their relative importance or preference. BWM typically involves presenting respondents with a set of alternatives and asking them to identify the best and worst alternatives from that set. The respondents then assign scores to the alternatives based on their perceived importance or preference. The scores are used to calculate the importance weights of each alternative, which can be used to prioritize DM and allocate resources accordingly. The BWM method is advantageous in situations where there are multiple attributes to be evaluated and subjective preferences are involved. It provides a more comprehensive and accurate assessment of DM criteria and helps decision-makers identify the most critical areas for improvement [104].

(i) Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) is used to evaluate and rank alternative solutions based on MC. The method measures the attractiveness of each alternative solution based on the criteria or factors considered. The method also ranks the alternatives according to a compromise solution. Then, the alternatives are rated according to their overall scores, with the highest-scoring alternative considered the most attractive. Overall, the method has been shown to provide a valuable tool for decision-makers to evaluate alternative solutions and identify areas for improvement [105–107].

(j) Goal programming is used to find the best possible solution to a problem with multiple conflicting objectives. The goal programming model involves identifying a set of objectives, which may be conflicting, and assigning priority weights to each objective. The model seeks to minimize the deviations from these objectives, subject to constraints. The objectives may include minimizing the cost of resource allocation, maximizing the efficiency of resource utilization, and meeting project deadlines. This model, used for allocation in agile-based software development, involves the identification of objectives and constraints, the determination of the priority weights for each objective, and the formulation of the goal programming model. The model is then solved using a mathematical optimization algorithm to determine the optimal resource allocation plan. The goal programming approach provides a helpful tool for decision-makers to allocate resources in a way that balances multiple competing objectives [108].

(k) Grey relational analysis (GRA) method is a technique for evaluating the relationships between multiple variables and identifying those variables that are most strongly related to the desired outcome. GRA method works by comparing each variable to the reference variable, which is typically the variable that represents the desired outcome. The method uses a grey number to represent each variable, which accounts for both the known and unknown information about the variable. The grey number is then used to calculate the grey relational coefficient (GRC) between each variable and the reference variable. The GRC indicates the degree of correlation between each variable and the reference variable, with a higher GRC indicating a stronger correlation. The variables with the highest GRCs are considered to be the most important for achieving the desired outcome and can be used to inform DM. The GRA method is used to evaluate the relationships between MC [39].

(l) Weighted Sum Aggregation (WSA) is a method of aggregating MC or factors that are used to evaluate alternatives in a DM process. A weight is assigned to each criterion in the WSA method to reflect its relative importance in the DM process. In order to calculate the weighted sum score for each alternative, the weights for each criterion are combined. As a result, the alternative with the highest weighted sum score is considered to be the most advantageous. WSA provides decision-makers with a useful tool for aggregating MC and determining the relative importance of each criterion [109].

A technique widely used in several Decision-Making tools is the fuzzy logic method, which is usually preferred to determine a rough and distant outcome from a variety of sources of information [25]. This is an effective tool for modelling vague, ambiguous, and inaccurate information. There are numerous applications of fuzzy set theory in the fields of engineering, management, and business. As an alternative approach to human judgments, Zadeh proposes linguistic variables, which essentially transform crisp values of information into fuzzy ones [110]. A fuzzy number $A^{\sim}$ is a convex, normalized fuzzy set of $X \subseteq R$ and indicated as $A = (l,m,u)$, where l and u represent the lower and upper bounds, respectively, and m is the midpoint [111]. It is worth mentioning that 9 out of 80 papers use methodologies combined with fuzziness. More specifically, the multi-criteria decision-making (MCDM) methods PROMETHEE method [24], Delphi method [37], ELECTRE method [77], and AHP [89] are developed with fuzzy logic as well as other combined methodologies [25,32,45,52,54].

In Table 3, the MCDM methods employed in the papers are compared, including their advantages, disadvantages, and fields of application.

Table 3. Overview of MCDM methods that employ the reviewed papers.

	Pros	Cons	Application	Source
AHP	• Flexible, intuitive and easy to use • Incorporate experts' viewpoints • Check inconsistency • No bias in DM • Makes clear the importance of each element	• Irregularities in ranking • Important information may be lost (Additive aggregation) • More pair-wise comparisons are needed • Difficult to reflect index interactions • Collection of data lies on experience	Company valuation methods in legal asset inventory expertise, construction management domain for material and project selection, health sector and manufacturing	[7,24,112,113]
ANP	• Handle complex index systems well • Processing feedback and interdependencies • Independence among elements is not required • Prediction is accurate because priorities are improved by feedback	• Fail to evaluate one element in isolation • Time-consuming • Complex computational processes • Uncertainty—not supported • Hard to convince DM	Health, safety and environmental management, hydrology and water management, business and financial management, human resources management, tourism, logistics and supply chain management, design, engineering and manufacturing systems, energy management	[24,100,112]
BWM	• Most data and time-efficient • Checking the consistency of pairwise comparisons	• No identification of a global (system) optimal solution • Weights that are not distinct and can impact the decision outcome • Complicated computational procedures, particularly with a large number of criteria.	Energy, supply chain management, transportation, manufacturing, education, investment, performance evaluation, airline industry, communication, healthcare, banking, technology, and tourism	[114,115]
DEMATEL	• Considering index interaction • Less required in data • Determining causal factors	• Complex computational processes • Lack of objectivity	Supply chain management, environmental planning, healthcare, finance, and engineering	[24,116]
DEPLHI	• Structured system of communication for clear results • Anonymity for unbiased responses • Flexibility in geographical location • Removal of the impact of dominant individuals • Time and cost-effective method of obtaining expert group opinion	• Limited open discussion • Requires commitment if multiple rounds are required • Interpretation of study results is highly dependent on the responder's expertise	Business forecasting, industry predictions, government planning or financial strategies, predict trends in aerospace, automation, broadband connections, and the use of technology in schools	[117,118]
ELECTRE	• DM by thresholds of indifference and preference • Handle the problem of index compensation • Application when the incomparable alternatives exist • Outranking is used	• Requires many parameters • Complex computational processes • Difficult to determine the preferred alternatives • Time-consuming	Engineering, economics, business, environmental management	[24,112,119]
Goal programming	• Handling large-scale problems • Provide infinite alternatives	• Capability of weighting coefficients • Need to be combined with other MCDM methods	Production planning, health care, portfolio selection, distribution systems, energy planning, water management, wildlife management	[120]

Table 3. *Cont.*

	Pros	Cons	Application	Source
GREY	• Perfect information results in a unique solution	• No optimal solution	Oil field development, military decisions, and equipment condition monitoring and wear mode recognition	[112,121]
MARCOS	• Subjectivity in expert judgment is exploited and assumptions are avoided • Consideration of an anti-ideal and ideal solution in the initial matrix, • Closer determination of utility degree in relation to both solutions, • Proposal of a new way to determine utility functions and their aggregation • Examination of an extensive array of criteria and alternatives while ensuring the steadfastness of the approach.	• A significant amount of data • New method/Not yet extensively investigated and used	Medical, logistics and transportation, life cycle management, materials selection, site selection problems, manufacturing process evaluation, technology evaluation	[106]
PROMETHEE	• No need for raw data process • Reduction in information loss • Reflect various properties of attributes	• Ignore the psychological characteristics of decision-makers	Business, finance, hydrology, and water management	[24,122]
TOPSIS	• Ease of application and understanding • Universality • Consideration of distances to an ideal solution • Not restricted sample size and index quantity • Ideal solution and anti-ideal solution complexity	• High subjectivity, not checking the consistency of judgments • Not indicate the preference of decision-makers • Ignore the relative importance of distances • Max. character of criteria calculation scale	Energy, medicine, engineering and manufacturing systems, safety and environmental fields, chemical engineering and water resources studies	[24,98,123]
Weighted Sum Algorithm (WSA)	• Weight and combine multiple inputs • Incorporation weights or relative importance • Max. of gain • Results min, max • Strong in a single-dimensional problem	• Linear function of gain • Exaggerating extremes • Difficulty with multi-dimensional problems	Economics, agriculture, and risk management	[112,123]

3.6. Criteria Used

In the 80 papers reviewed, a comprehensive set of 170 criteria was utilized and subsequently categorized, leading to a condensed list of 41 final criteria. According to Figure 10 (and more analytically in Table S5, which describes the criteria selected and analysed in 80 papers and the number of papers that examined them), the most frequently employed criteria related to wind characteristics and water depth (approximately 75% of papers referring to these criteria), navigation and energy criteria (65% of papers), and baseline criteria regarding environmental impacts and distance from the shoreline (54%).

While the above criteria seem to be the only ones used in a percentage greater than 50% of the total papers, there are other factors to complete a holistic examination of spatial planning, related to social and economic factors, i.e., population served, acceptance, employment, various economic indicators, etc., as well as crucial legal and exclusive criteria, including distance from ports and airports, underwater cables, or military prohibited zones.

Several criteria have not yet been extensively explored (Figure 10). In terms of spatial planning, some of these appear to be important, such as policy planning, heritage areas, and the existence of renewable energy sources, while others are less well explored, such as the marine habitat and conditions or the safety level. Additionally, it is noted that some of those unstudied criteria are essential for such research to harvest increased endorsement from the local community residents and to investigate the benefits and negative impacts of the installation holistically [124].

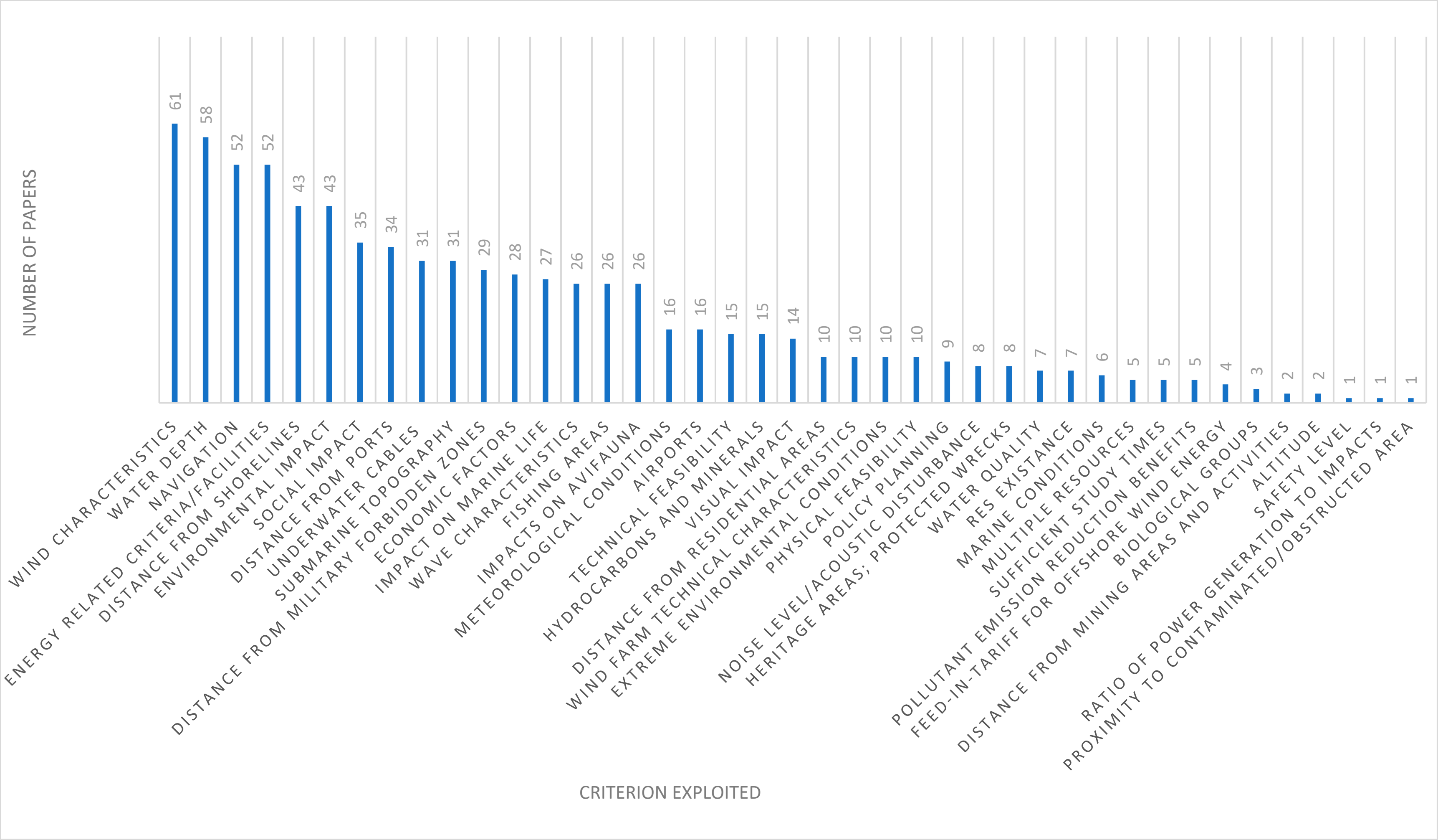

Figure 10. Number of papers exploiting each type of criterion.

3.7. Experts Included

The majority of papers (39 out of 80) seem to lack expert opinions concerning their criteria or, more broadly, their methodology. The authors also appear to classify the criteria based on their expertise and knowledge, but this is a time-consuming process, which is not objective, and the results are not in accordance with reality. A percentage of 11%, 9 papers do not specify whether or not they include expert opinions in their studies and another percentage of 11%, 9 papers include expert opinions but do not specify the number. A satisfactory number of papers is reviewed in addition to a number of expert opinions, such as 4, 5, 7, or 9. Last but not least, a less widely adopted practice consists of the opinions of 3, 8, 10, 13, 15, 21, 25, 26, 33, and 34 experts (Figure 11 and Table 1).

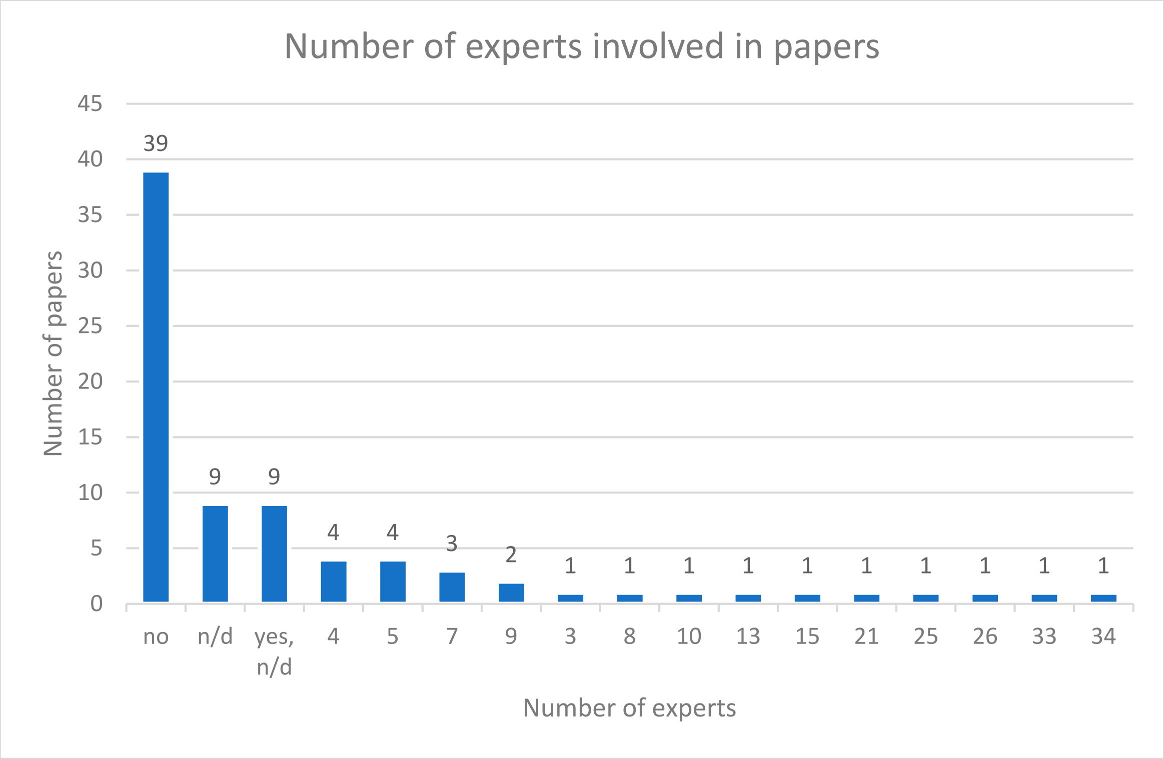

Figure 11. Number of experts, including in reviewed papers.

4. Conclusions

This study involves a systematic literature review that critically and comprehensively analyses publications to identify constraints and relevant criteria for determining the optimal location for offshore wind development. The review also offers insights into the methods and criteria employed in the examined articles. The subsequent paragraphs summarize the main findings derived from the obtained results.

The reviewed studies are allocated among 34 distinct scholarly journals, predominantly featured in the journals Renewable Energy, Renewable and Sustainable Energy Reviews, and Energies. A significant variation in the distribution of different journals indicates that the Offshore Wind market is becoming increasingly challenging, as well as demonstrating that there is a multidisciplinary interest in this emerging technology and that many scientists are concentrating on it.

According to the study area, the studies were conducted in 24 different study areas, with the highest percentage being undertaken in Turkey, China, and Greece. When the conditions are favourable in terms of economic status, studies, legislation, and mature technology, countries with sea areas that have not developed Offshore Wind installations undertake research in order to be prepared for development.

Among the 80 studies, 30 examine the siting of bottom-fixed OWFs, 12 examine the new emerging technology of floating OWFs, and 27 examine both types (bottom-fixed and floating).

It was found that 40 of the 80 papers reviewed (50%) applied MCDM methods in order to assess which sites would be most appropriate for the deployment of OWFs. The global literature confirms that these kinds of methods are particularly suitable for approximating multi-parameter problems, such as the optimal location of OWFs. It is also worth noting that 20 out of 80 papers (25%) use the AHP method as the basis for identifying optimal OWF locations, which means that this is a method that has been thoroughly tested and verified and can be applied in this sector widely. Based on the analysis, it is estimated that the most popular methods (AHP, TOPSIS, PROMETHEE) offer a strong competitive advantage of being easy to use and understand, although their accuracy is based on the quality of the selected panel and have a large phasma of applications in business, as well as in policy making.

As concerns the criteria in the existing Science and Technology literature there exist an adequate number of examples in different sectors, including criteria such as wind potential characteristics, water depth, energy, distance from shore, social and environmental impact, and economy ready-to-use (TRL above 8). On the contrary, crucial criteriafor the final decision are less developed (TRL below 5), such as visual impact, extreme environmental conditions and safety, noise level, and protection of the natural system and heritage sites (including coastal antiquities).

OWFs encounter various limitations that hinder their widespread adoption and operation. The substantial depths of offshore locations significantly escalate installation costs, making them less economically feasible compared to alternative solutions like floating wind farms. Moreover, the sluggish pace of licensing procedures adds to project delays and uncertainties, further impeding progress. Extensive studies are required for aspects such as electrical connections, local environmental impacts, and precise wind measurements, contributing to the complexity and duration of project development. Additionally, the unpredictability of energy tariffs poses financial risks, while the high costs associated with installation and maintenance strain project budgets. Upgrading port and shipyard facilities to accommodate offshore installations is another significant challenge. Furthermore, social opposition, often driven by the NIMBY (Not In My Backyard) phenomenon, presents formidable obstacles to offshore wind farm developments, necessitating careful community engagement and stakeholder collaboration to overcome [125].

Future research in the realm of OWFs should focus on enhancing decision-making processes and optimizing project outcomes. This could involve incorporating additional criteria and increasing the involvement of experts in decision-making processes, alongside utilizing a combination of MCDM methods for more robust evaluations. Techno-economic assessments should be conducted for various suitable areas, considering different micro-siting scenarios and turbine models to maximize efficiency and cost-effectiveness. Moreover, assessing potential visual impacts using innovative methods and verifying results could help address concerns and inform project planning [126,127]. Crucial criteria for further investigation include visual impacts, extreme environmental conditions, noise levels, and the presence of heritage sites, including coastal antiquities. Encouraging the participation of experts can lead to a more objective assessment of data and improve decision-making processes. Additionally, comprehensive studies focusing on the marine ecosystem are essential, requiring on-site assessments of wind measurements, environmental impacts, and visual impact evaluations for each specific location. Lastly, examining maintenance criteria in relation to the distance from ports is vital for ensuring efficient operations and reducing downtime [125].

The reviewed studies inadequately address or overlook certain critical issues, such as the marine ecosystem. These aspects are pivotal for determining the location, installation, and operation of facilities like OWFs. A comprehensive risk analysis, tailored to the specific characteristics of each region, is essential, encompassing uncertainties at technical, economic, social, and environmental levels. While these studies serve as an initial step in identifying suitable sites for offshore wind farm deployment, achieving a more thorough and accurate approach necessitates on-site studies, wind measurements, environmental assessments, and visual impact evaluations for each local site.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16146036/s1, Table S1: Number of experts involved in the multicriteria process of the 80 papers; Table S2: Allocation of papers per study area, type of structure, journal, expert involvement, and GIS integration; Table S3: Allocation per paper according to the used methodology. *In column "paper ref", numbers indicate the "A/A" of each paper, as it is assigned in Table S2; Table S4: Allocation per MCDM method. *In column "paper ref", numbers indicate the "A/A" of each paper, as it is assigned in Table S2; Table S5: Criteria chosen and analysed in 80 papers and the reference and number of papers that investigates them. *In column "paper ref", numbers indicate the "A/A" of each paper, as it is assigned in Table S2.

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Abbreviation

AHP	Analytic Hierarchy Process
ANP	Analytic network process
BWM	Best-Worst Method
DM	Decision-making
DEMATEL	Decision Making Trial and Evaluation Laboratory
ELECTRE	ELimination and Choice Expressing Reality
GHG	Greenhouse Gas
GIS	Geographic Information System
GRA	Grey Relational Analysis
GRC	Grey Relational Coefficient
MARCOS	Measurement of Alternatives and Ranking according to Compromise Solution
MCDM	Multi-Criteria Decision-Making
MC	Multiple criteria
OWF(s)	Offshore Wind Farm(s)
PROMETHEE	Preference Ranking Organization METHod for Enrichment Evaluation
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
UK	United Kingdom
WSA	Weighted Sum Aggregation

References

1. Global Wind Energy Council. Global Offshore Wind Report 2023. 2023. Available online: https://gwec.net/wp-content/uploads/2023/08/GWEC-Global-Offshore-Wind-Report-2023.pdf (accessed on 15 April 2024).
2. Wind Energy Barometer 2024—EurObserv'ER." n.d. Available online: https://www.eurobserv-er.org/wind-energy-barometer-2024/ (accessed on 12 May 2024).
3. Susini, S.; Menendez, M.; Eguia, P.; Blanco, J.M. Climate Change Impact on the Offshore Wind Energy Over the North Sea and the Irish Sea. *Front. Energy Res.* **2022**, *10*, 881146. [CrossRef]
4. European Parliament. COM(2020)741—EU Strategy to Harness the Potential of Offshore Renewable Energy for a Climate Neutral Future—EU Monitor. 2020. Available online: https://www.eumonitor.eu/9353000/1/j9vvik7m1c3gyxp/vldwjbykscwq (accessed on 15 April 2024).
5. COM/2023/669 Final. 2023. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023DC0668&qid=1702455230867 (accessed on 15 April 2024).
6. Peters, J.L.; Remmers, T.; Wheeler, A.J.; Murphy, J.; Cummins, V. A Systematic Review and Meta-Analysis of GIS Use to Reveal Trends in Offshore Wind Energy Research and Offer Insights on Best Practices. *Renew. Sustain. Energy Rev.* **2020**, *128*, 109916. [CrossRef]
7. Gkeka-Serpetsidaki, P.; Tsoutsos, T. A Methodological Framework for Optimal Siting of Offshore Wind Farms: A Case Study on the Island of Crete. *Energy* **2022**, *239*, 122296. [CrossRef]

8. Hou, G.; Xu, K.; Lian, J. A Review on Recent Risk Assessment Methodologies of Offshore Wind Turbine Foundations. *Ocean Eng.* **2022**, *264*, 112469. [CrossRef]
9. Jiang, Z. Installation of Offshore Wind Turbines: A Technical Review. *Renew. Sustain. Energy Rev.* **2021**, *139*, 110576. [CrossRef]
10. Jahani, K.; Langlois, R.G.; Afagh, F.F. Structural Dynamics of Offshore Wind Turbines: A Review. *Ocean Eng.* **2022**, *251*, 111136. [CrossRef]
11. Abramic, A.; Cordero-Penin, V.; Haroun, R. Environmental Impact Assessment Framework for Offshore Wind Energy Developments Based on the Marine Good Environmental Status. *Environ. Impact Assess. Rev.* **2022**, *97*, 106862. [CrossRef]
12. Croll, D.A.; Ellis, A.A.; Adams, J.; Cook, A.S.; Garthe, S.; Goodale, M.W.; Hall, C.S.; Hazen, E.; Keitt, B.S.; Kelsey, E.C.; et al. Framework for Assessing and Mitigating the Impacts of Offshore Wind Energy Development on Marine Birds. *Biol. Conserv.* **2022**, *276*, 109795. [CrossRef]
13. Hall, R.; Topham, E.; João, E. Environmental Impact Assessment for the Decommissioning of Offshore Wind Farms. *Renew. Sustain. Energy Rev.* **2022**, *165*, 112580. [CrossRef]
14. Hernandez, C.O.M.; Shadman, M.; Amiri, M.M.; Silva, C.; Estefen, S.F.; La Rovere, E. Environmental Impacts of Offshore Wind Installation, Operation and Maintenance, and Decommissioning Activities: A Case Study of Brazil. *Renew. Sustain. Energy Rev.* **2021**, *144*, 110994. [CrossRef]
15. De Salvo, M.; Notaro, S.; Cucuzza, G.; Giuffrida, L.; Signorello, G. Protecting the Local Landscape or Reducing Greenhouse Gas Emissions? A Study on Social Acceptance and Preferences towards the Installation of a Wind Farm. *Sustainability* **2021**, *13*, 12755. [CrossRef]
16. Tsarknias, N.; Gkeka-Serpetsidaki, P.; Tsoutsos, T. Exploring the Sustainable Siting of Floating Wind Farms in the Cretan Coastline. *Sustain. Energy Technol. Assess.* **2022**, *54*, 102841. [CrossRef]
17. Shao, M.; Han, Z.; Sun, J.; Xiao, C.; Zhang, S.; Zhao, Y. A Review of Multi-Criteria Decision Making Applications for Renewable Energy Site Selection. *Renew. Energy* **2020**, *157*, 377–403. [CrossRef]
18. Liu, Q.; Sun, Y.; Wu, M. Decision-Making Methodologies in Offshore Wind Power Investments: A Review. *J. Clean. Prod.* **2021**, *295*, 126459. [CrossRef]
19. Mytilinou, V.; Lozano-Minguez, E.; Kolios, A. A Framework for the Selection of Optimum Offshore Wind Farm Locations for Deployment. *Energies* **2018**, *11*, 1855. [CrossRef]
20. Stefanakou, A.A.; Nikitakos, N.; Lilas, T.; Pavlogeorgatos, G. A GIS-Based Decision Support Model for Offshore Floating Wind Turbine Installation. *Int. J. Sustain. Energy* **2019**, *38*, 673–691. [CrossRef]
21. Tercan, E.; Tapkın, S.; Latinopoulos, D.; Dereli, M.A.; Tsiropoulos, A.; Ak, M.F. A GIS-Based Multi-Criteria Model for Offshore Wind Energy Power Plants Site Selection in Both Sides of the Aegean Sea. *Environ. Monit. Assess.* **2020**, *192*, 652. [CrossRef] [PubMed]
22. Díaz, H.; Soares, C.G. A Multi-Criteria Approach to Evaluate Floating Offshore Wind Farms Siting in the Canary Islands (Spain). *Energies* **2021**, *14*, 865. [CrossRef]
23. Mekonnen, A.D.; Gorsevski, P.V. A Web-Based Participatory GIS (PGIS) for Offshore Wind Farm Suitability within Lake Erie, Ohio. *Renew. Sustain. Energy Rev.* **2015**, *41*, 162–177. [CrossRef]
24. Wu, Y.; Tao, Y.; Zhang, B.; Wang, S.; Xu, C.; Zhou, J. A Decision Framework of Offshore Wind Power Station Site Selection Using a PROMETHEE Method under Intuitionistic Fuzzy Environment: A Case in China. *Ocean Coast. Manag.* **2020**, *184*, 105016. [CrossRef]
25. Wu, B.; Yip, T.L.; Xie, L.; Wang, Y. A Fuzzy-MADM Based Approach for Site Selection of Offshore Wind Farm in Busy Waterways in China. *Ocean Eng.* **2018**, *168*, 121–132. [CrossRef]
26. Pınarbaşı, K.; Galparsoro, I.; Depellegrin, D.; Bald, J.; Pérez-Morán, G.; Borja, Á. A Modelling Approach for Offshore Wind Farm Feasibility with Respect to Ecosystem-Based Marine Spatial Planning. *Sci. Total Environ.* **2019**, *667*, 306–317. [CrossRef] [PubMed]
27. Jones, D.F.; Wall, G. An Extended Goal Programming Model for Site Selection in the Offshore Wind Farm Sector. *Ann. Oper. Res.* **2015**, *245*, 121–135. [CrossRef]
28. Wu, Y.; Chen, K.; Xu, H.; Xu, C.; Zhang, H.; Yang, M. An Innovative Method for Offshore Wind Farm Site Selection Based on the Interval Number with Probability Distribution. *Eng. Optim.* **2017**, *49*, 2174–2192. [CrossRef]
29. Cavazzi, S.; Dutton, A. An Offshore Wind Energy Geographic Information System (OWE-GIS) for Assessment of the UK's Offshore Wind Energy Potential. *Renew. Energy* **2016**, *87*, 212–228. [CrossRef]
30. Abdel-Basset, M.; Gamal, A.; Chakrabortty, R.K.; Ryan, M. A New Hybrid Multi-Criteria Decision-Making Approach for Location Selection of Sustainable Offshore Wind Energy Stations: A Case Study. *J. Clean. Prod.* **2021**, *280*, 124462. [CrossRef]
31. Díaz, H.; Soares, C.G. An Integrated GIS Approach for Site Selection of Floating Offshore Wind Farms in the Atlantic Continental European Coastline. *Renew. Sustain. Energy Rev.* **2020**, *134*, 110328. [CrossRef]
32. Xue, J.; Yip, T.L.; Wu, B.; Wu, C.; van Gelder, P. A Novel Fuzzy Bayesian Network-Based MADM Model for Offshore Wind Turbine Selection in Busy Waterways: An Application to a Case in China. *Renew. Energy* **2021**, *172*, 897–917. [CrossRef]
33. Fetanat, A.; Khorasaninejad, E. A Novel Hybrid MCDM Approach for Offshore Wind Farm Site Selection: A Case Study of Iran. *Ocean Coast. Manag.* **2015**, *109*, 17–28. [CrossRef]
34. Díaz, H.; Soares, C.G. A Novel Multi-Criteria Decision-Making Model to Evaluate Floating Wind Farm Locations. *Renew. Energy* **2021**, *185*, 431–454. [CrossRef]

35. Nezhad, M.M.; Neshat, M.; Groppi, D.; Marzialetti, P.; Heydari, A.; Sylaios, G.; Garcia, D.A. A Primary Offshore Wind Farm Site Assessment Using Reanalysis Data: A Case Study for Samothraki Island. *Renew. Energy* **2021**, *172*, 667–679. [CrossRef]
36. Guo, Q.; Huang, R.; Zhuang, L.; Zhang, K.; Huang, J. Assessment of China's Offshore Wind Resources Based on the Integration of Multiple Satellite Data and Meteorological Data. *Remote Sens.* **2019**, *11*, 2680. [CrossRef]
37. Deveci, M.; Özcan, E.; John, R.; Covrig, C.-F.; Pamucar, D. A Study on Offshore Wind Farm Siting Criteria Using a Novel Interval-Valued Fuzzy-Rough Based Delphi Method. *J. Environ. Manag.* **2020**, *270*, 110916. [CrossRef] [PubMed]
38. Vinhoza, A.; Schaeffer, R. Brazil's Offshore Wind Energy Potential Assessment Based on a Spatial Multi-Criteria Decision Analysis. *Renew. Sustain. Energy Rev.* **2021**, *146*, 111185. [CrossRef]
39. Lo, H.W.; Hsu, C.C.; Chen, B.C.; Liou, J.J. Building a Grey-Based Multi-Criteria Decision-Making Model for Offshore Wind Farm Site Selection. *Sustain. Energy Technol. Assess.* **2020**, *43*, 100935. [CrossRef]
40. Ho, L.-W.; Lie, T.T.; Leong, P.T.; Clear, T. Developing Offshore Wind Farm Siting Criteria by Using an International Delphi Method. *Energy Policy* **2018**, *113*, 53–67. [CrossRef]
41. Loughney, S.; Wang, J.; Bashir, M.; Armin, M.; Yang, Y. Development and Application of a Multiple-Attribute Decision-Analysis Methodology for Site Selection of Floating Offshore Wind Farms on the UK Continental Shelf. *Sustain. Energy Technol. Assess.* **2021**, *47*, 101440. [CrossRef]
42. dos Reis, M.M.L.; Mazetto, B.M.; da Silva, E.C.M. Economic Analysis for Implantation of an Offshore Wind Farm in the Brazilian Coast. *Sustain. Energy Technol. Assess.* **2021**, *43*, 100955. [CrossRef]
43. Argin, M.; Yerci, V.; Erdogan, N.; Kucuksari, S.; Cali, U. Exploring the Offshore Wind Energy Potential of Turkey Based on Multi-Criteria Site Selection. *Energy Strat. Rev.* **2019**, *23*, 33–46. [CrossRef]
44. Satir, M.; Murphy, F.; McDonnell, K. Feasibility Study of an Offshore Wind Farm in the Aegean Sea, Turkey. *Renew. Sustain. Energy Rev.* **2018**, *81*, 2552–2562. [CrossRef]
45. Gil-García, I.C.; Ramos-Escudero, A.; García-Cascales, M.; Dagher, H.; Molina-García, A. Fuzzy GIS-Based MCDM Solution for the Optimal Offshore Wind Site Selection: The Gulf of Maine Case. *Renew. Energy* **2022**, *183*, 130–147. [CrossRef]
46. Gavériaux, L.; Laverrière, G.; Wang, T.; Maslov, N.; Claramunt, C. GIS-Based Multi-Criteria Analysis for Offshore Wind Turbine Deployment in Hong Kong. *Ann. GIS* **2019**, *25*, 207–218. [CrossRef]
47. Colak, T.A.I.; Senel, G.; Goksel, C. GIS-Based Maritime Spatial Planning for Site Selection of Offshore Wind Farms with Exergy Efficiency Analysis: A Case Study. *Int. J. Exergy* **2021**, *34*, 255. [CrossRef]
48. Taoufik, M.; Fekri, A. GIS-Based Multi-Criteria Analysis of Offshore Wind Farm Development in Morocco. *Energy Convers. Manag. X* **2021**, *11*, 100103. [CrossRef]
49. Vasileiou, M.; Loukogeorgaki, E.; Vagiona, D.G. GIS-Based Multi-Criteria Decision Analysis for Site Selection of Hybrid Offshore Wind and Wave Energy Systems in Greece. *Renew. Sustain. Energy Rev.* **2017**, *73*, 745–757. [CrossRef]
50. Sourianos, E.; Kyriakou, K.; Hatiris, G.A. GIS-Based Spatial Decision Support System for the Optimum Siting of Offshore Windfarms. *Eur. Water* **2017**, *58*, 337–343.
51. Guinan, J.; McKeon, C.; O'Keeffe, E.; Monteys, X.; Sacchetti, F.; Coughlan, M.; Nic Aonghusa, C. INFOMAR Data Supports Offshore Energy Development and Marine Spatial Planning in the Irish Offshore via the Emodnet Geology Portal. *Q. J. Eng. Geol. Hydrogeol.* **2020**, *54*, qjegh2020-033. [CrossRef]
52. Deveci, M.; Cali, U.; Kucuksari, S.; Erdogan, N. Interval Type-2 Fuzzy Sets Based Multi-Criteria Decision-Making Model for Offshore Wind Farm Development in Ireland. *Energy* **2020**, *198*, 117317. [CrossRef]
53. Abramic, A.; García Mendoza, A.; Haroun, R. Introducing Offshore Wind Energy in the Sea Space: Canary Islands Case Study Developed under Maritime Spatial Planning Principles. *Renew. Sustain. Energy Rev.* **2021**, *145*, 111119. [CrossRef]
54. Zhang, X.-Y.; Zhang, X.-Y.; Wang, X.-K.; Wang, X.-K.; Yu, S.-M.; Yu, S.-M.; Wang, J.-Q.; Wang, J.-Q.; Wang, T.-L.; Wang, T.-L. Location Selection of Offshore Wind Power Station by Consensus Decision Framework Using Picture Fuzzy Modelling. *J. Clean. Prod.* **2018**, *202*, 980–992. [CrossRef]
55. Castro-Santos, L.; Lamas-Galdo, M.I.; Filgueira-Vizoso, A. Managing the Oceans: Site Selection of a Floating Offshore Wind Farm Based on GIS Spatial Analysis. *Mar. Policy* **2019**, *113*, 103803. [CrossRef]
56. Mahdy, M.; Bahaj, A.S. Multi Criteria Decision Analysis for Offshore Wind Energy Potential in Egypt. *Renew. Energy* **2018**, *118*, 278–289. [CrossRef]
57. Gao, J.; Guo, F.; Ma, Z.; Huang, X.; Li, X. Multi-Criteria Group Decision-Making Framework for Offshore Wind Farm Site Selection Based on the Intuitionistic Linguistic Aggregation Operators. *Energy* **2020**, *204*, 117899. [CrossRef]
58. Chaouachi, A.; Covrig, C.F.; Ardelean, M. Multi-Criteria Selection of Offshore Wind Farms: Case Study for the Baltic States. *Energy Policy* **2017**, *103*, 179–192. [CrossRef]
59. Cradden, L.; Kalogeri, C.; Barrios, I.M.; Galanis, G.; Ingram, D.; Kallos, G. Multi-Criteria Site Selection for Offshore Renewable Energy Platforms. *Renew. Energy* **2016**, *87*, 791–806. [CrossRef]
60. Martinez, A.; Iglesias, G. Multi-Parameter Analysis and Mapping of the Levelised Cost of Energy from Floating Offshore Wind in the Mediterranean Sea. *Energy Convers. Manag.* **2021**, *243*, 114416. [CrossRef]
61. Rae, G.; Erfort, G. Offshore Wind Energy—South Africa's Untapped Resource. *J. Energy S. Afr.* **2020**, *31*, 26–42. [CrossRef]
62. Zhang, Y.; Zhang, C.; Chang, Y.C.; Liu, W.H. Offshore Wind Farm in Marine Spatial Planning and the Stakeholders Engagement: Opportunities and Challenges for Taiwan. *Ocean Coast. Manag.* **2017**, *149*, 69–80. [CrossRef]

63. Kim, T.; Park, J.I.; Maeng, J. Offshore Wind Farm Site Selection Study around Jeju Island, South Korea. *Renew. Energy* **2016**, *94*, 619–628. [CrossRef]
64. Deveci, M.; Özcan, E.; John, R.; Pamucar, D.; Karaman, H. Offshore Wind Farm Site Selection Using Interval Rough Numbers Based Best-Worst Method and MARCOS. *Appl. Soft Comput.* **2021**, *109*, 107532. [CrossRef]
65. Waewsak, J.; Landry, M.; Gagnon, Y. Offshore Wind Power Potential of the Gulf of Thailand. *Renew. Energy* **2015**, *81*, 609–626. [CrossRef]
66. Ou, L.; Xu, W.; Yue, Q.; Ma, C.L.; Teng, X.; Dong, Y.E. Offshore Wind Zoning in China: Method and Experience. *Ocean Coast. Manag.* **2018**, *151*, 99–108. [CrossRef]
67. Wu, Y.; Zhang, T.; Xu, C.; Zhang, B.; Li, L.; Ke, Y.; Yan, Y.; Xu, R. Optimal Location Selection for Offshore Wind-PV-Seawater Pumped Storage Power Plant Using a Hybrid MCDM Approach: A Two-Stage Framework. *Energy Convers. Manag.* **2019**, *199*, 112066. [CrossRef]
68. Saenz-Aguirre, A.; Saenz, J.; Ulazia, A.; Ibarra-Berastegui, G. Optimal Strategies of Deployment of Far Offshore Co-Located Wind-Wave Energy Farms. *Energy Convers. Manag.* **2022**, *251*, 114914. [CrossRef]
69. Castro-Santos, L.; Garcia, G.P.; Simões, T.; Estanqueiro, A. Planning of the Installation of Offshore Renewable Energies: A GIS Approach of the Portuguese Roadmap. *Renew. Energy* **2019**, *132*, 1251–1262. [CrossRef]
70. Gomes, M.S.d.S.; de Paiva, J.M.F.; Moris, V.A.d.S.; Nunes, A.O. Proposal of a Methodology to Use Offshore Wind Energy on the Southeast Coast of Brazil. *Energy* **2019**, *185*, 327–336. [CrossRef]
71. Bravo, M.; Jones, D.; Pla-Santamaria, D.; Wall, G. Robustness of Weighted Goal Programming Models: An Analytical Measure and Its Application to Offshore Wind-Farm Site Selection in United Kingdom. *Ann. Oper. Res.* **2018**, *267*, 65–79. [CrossRef]
72. Shafinejad, M.M.; Abedi, M. Selection of Suitable Sites for Offshore Wind Farms in the Caspian Sea and Choosing the Most Suitable Wind Turbine in Each Area. *Wind. Eng.* **2019**, *45*, 294–313. [CrossRef]
73. Loukogeorgaki, E.; Vagiona, D.G.; Vasileiou, M. Site Selection of Hybrid Offshore Wind and Wave Energy Systems in Greece Incorporating Environmental Impact Assessment. *Energies* **2018**, *11*, 2095. [CrossRef]
74. Kim, C.K.; Jang, S.; Kim, T.Y. Site Selection for Offshore Wind Farms in the Southwest Coast of South Korea. *Renew. Energy* **2018**, *120*, 151–162. [CrossRef]
75. Schallenberg-Rodríguez, J.; Montesdeoca, N.G. Spatial Planning to Estimate the Offshore Wind Energy Potential in Coastal Regions and Islands. Practical Case: The Canary Islands. *Energy* **2018**, *143*, 91–103. [CrossRef]
76. Spyridonidou, S.; Vagiona, D.G.; Loukogeorgaki, E. Strategic Planning of Offshore Wind Farms in Greece. *Sustainability* **2020**, *12*, 905. [CrossRef]
77. Wu, Y.; Zhang, J.; Yuan, J.; Geng, S.; Zhang, H. Study of Decision Framework of Offshore Wind Power Station Site Selection Based on ELECTRE-III under Intuitionistic Fuzzy Environment: A Case of China. *Energy Convers. Manag.* **2016**, *113*, 66–81. [CrossRef]
78. Genç, M.S.; Karipoğlu, F.; Koca, K.; Azgın, Ş.T. Suitable Site Selection for Offshore Wind Farms in Turkey's Seas: GIS-MCDM Based Approach. *Earth Sci. Inform.* **2021**, *14*, 1213–1225. [CrossRef]
79. Vagiona, D.G.; Kamilakis, M. Sustainable Site Selection for Offshore Wind Farms in the South Aegean—Greece. *Sustainability* **2018**, *10*, 749. [CrossRef]
80. Christoforaki, M.; Tsoutsos, T. Sustainable Siting of an Offshore Wind Park a Case in Chania, Crete. *Renew. Energy* **2017**, *109*, 624–633. [CrossRef]
81. Cali, U.; Erdogan, N.; Kucuksari, S.; Argin, M. Techno-Economic Analysis of High Potential Offshore Wind Farm Locations in Turkey. *Energy Strat. Rev.* **2018**, *22*, 325–336. [CrossRef]
82. Remmers, T.; Cawkwell, F.; Desmond, C.; Murphy, J.; Politi, E. The Potential of Advanced Scatterometer (ASCAT) 12.5 Km Coastal Observations for Offshore Wind Farm Site Selection in Irish Waters. *Energies* **2019**, *12*, 206. [CrossRef]
83. Emeksiz, C.; Demirci, B. The Determination of Offshore Wind Energy Potential of Turkey by Using Novelty Hybrid Site Selection Method. *Sustain. Energy Technol. Assess.* **2019**, *36*, 100562. [CrossRef]
84. Golestani, N.; Arzaghi, E.; Abbassi, R.; Garaniya, V.; Abdussamie, N.; Yang, M. The Game of Guwarra: A Game Theory-Based Decision-Making Framework for Site Selection of Offshore Wind Farms in Australia. *J. Clean. Prod.* **2021**, *326*, 129358. [CrossRef]
85. Deveci, M.; Erdogan, N.; Cali, U.; Stekli, J.; Zhong, S. Type-2 Neutrosophic Number Based Multi-Attributive Border Approximation Area Comparison (MABAC) Approach for Offshore Wind Farm Site Selection in USA. *Eng. Appl. Artif. Intell.* **2021**, *103*, 104311. [CrossRef]
86. Ziemba, P. Uncertain Multi-Criteria Analysis of Offshore Wind Farms Projects Investments—Case Study of the Polish Economic Zone of the Baltic Sea. *Appl. Energy* **2022**, *309*, 118232. [CrossRef]
87. Ziemba, P.; Wątróbski, J.; Zioło, M.; Karczmarczyk, A. Using the PROSA Method in Offshore Wind Farm Location Problems. *Energies* **2017**, *10*, 1755. [CrossRef]
88. Faraggiana, E.; Ghigo, A.; Sirigu, M.; Petracca, E.; Giorgi, G.; Mattiazzo, G.; Bracco, G. Optimal Floating Offshore Wind Farms for Mediterranean Islands. *Renew. Energy* **2024**, *221*, 119785. [CrossRef]
89. Karipoğlu, F.; Ozturk, S.; Efe, B. A GIS-Based FAHP and FEDAS Analysis Framework for Suitable Site Selection of a Hybrid Offshore Wind and Solar Power Plant. *Energy Sustain. Dev.* **2023**, *77*, 101349. [CrossRef]
90. Önden, I.; Kara, K.; Yalçın, G.C.; Deveci, M.; Önden, A.; Eker, M. Strategic Location Analysis for Offshore Wind Farms to Sustainably Fulfill Railway Energy Demand in Turkey. *J. Clean. Prod.* **2024**, *434*, 140142. [CrossRef]

91. Martinez, A.; Iglesias, G. Techno-Economic Assessment of Potential Zones for Offshore Wind Energy: A Methodology. *Sci. Total Environ.* **2024**, *909*, 168585. [CrossRef] [PubMed]
92. Salvador, C.B.; Arzaghi, E.; Yazdi, M.; Jahromi, H.A.; Abbassi, R. A Multi-Criteria Decision-Making Framework for Site Selection of Offshore Wind Farms in Australia. *Ocean Coast. Manag.* **2022**, *224*, 106196. [CrossRef]
93. Sim, J. An Economic Evaluation of Potential Offshore Wind Farm Sites in South Korea Using a Real Options Approach. *Energy Rep.* **2023**, *10*, 29–37. [CrossRef]
94. Solbrekke, I.M.; Sorteberg, A. Norwegian Offshore Wind Power—Spatial Planning Using Multi-Criteria Decision Analysis. *Wind. Energy* **2024**, *27*, 5–32. [CrossRef]
95. Ospino-Castro, A.; Robles-Algarín, C.; Mangones-Cordero, A.; Romero-Navas, S. An Analytic Hierarchy Process Based Approach for Evaluating Feasibility of Offshore Wind Farm on the Colombian Caribbean Coast. *Int. J. Energy Econ. Policy* **2023**, *13*, 64–73. [CrossRef]
96. Boussarie, G.; Kopp, D.; Lavialle, G.; Mouchet, M.; Morfin, M. Marine Spatial Planning to Solve Increasing Conflicts at Sea: A Framework for Prioritizing Offshore Windfarms and Marine Protected Areas. *J. Environ. Manag.* **2023**, *339*, 117857. [CrossRef] [PubMed]
97. Polykarpou, M.; Karathanasi, F.; Soukissian, T.; Loukaidi, V.; Kyriakides, I. A Novel Data-Driven Tool Based on Non-Linear Optimization for Offshore Wind Farm Siting. *Energies* **2023**, *16*, 2235. [CrossRef]
98. Zulqarnain, R.M.; Saeed, M.; Ahmad, N.; Dayan, F.; Ahmad, B. Application of TOPSIS Method for Decision Making. 2020. Available online: https://www.researchgate.net/publication/342347772_Application_of_TOPSIS_Method_for_Decision_Making (accessed on 15 April 2024).
99. Vargas, L.G. An Overview of the Analytic Hierarchy Process and Its Applications. *Eur. J. Oper. Res.* **1990**, *48*, 2–8. [CrossRef]
100. Kheybari, S.; Rezaie, F.M.; Farazmand, H. Analytic Network Process: An Overview of Applications. *Appl. Math. Comput.* **2020**, *367*, 124780. [CrossRef]
101. Deng, J.; Zhan, J.; Wu, W.Z. A Ranking Method with a Preference Relation Based on the PROMETHEE Method in Incomplete Multi-Scale Information Systems. *Inf. Sci.* **2022**, *608*, 1261–1282. [CrossRef]
102. Kobryń, A. Dematel as a Weighting Method in Multi-Criteria Decision Analysis. *Mult. Criter-Decis. Mak.* **2017**, *12*, 153–167. [CrossRef]
103. Akram, M.; Sultan, M.; Alcantud, J.C.R. An Integrated ELECTRE Method for Selection of Rehabilitation Center with M-Polar Fuzzy N-Soft Information. *Artif. Intell. Med.* **2023**, *135*, 102449. [CrossRef] [PubMed]
104. Rezaei, J.; Kothadiya, O.; Tavasszy, L.; Kroesen, M. Quality Assessment of Airline Baggage Handling Systems Using SERVQUAL and BWM. *Tour. Manag.* **2018**, *66*, 85–93. [CrossRef]
105. Görçün, Ö.F.; Doğan, G. Mobile Crane Selection in Project Logistics Operations Using Best and Worst Method (BWM) and Fuzzy Measurement of Alternatives and Ranking According to COmpromise Solution (MARCOS). *Autom. Constr.* **2023**, *147*, 104729. [CrossRef]
106. Stević, Ž.; Pamucar, D.; Puška, A.; Chatterjee, P. Sustainable Supplier Selection in Healthcare Industries Using a New MCDM Method: Measurement of Alternatives and Ranking According to COmpromise Solution (MARCOS). *Comput. Ind. Eng.* **2020**, *140*, 106231. [CrossRef]
107. Ecer, F.; Pamucar, D. MARCOS Technique under Intuitionistic Fuzzy Environment for Determining the COVID-19 Pandemic Performance of Insurance Companies in Terms of Healthcare Services. *Appl. Soft Comput.* **2021**, *104*, 107199. [CrossRef] [PubMed]
108. Kaur, J.; Singh, O.; Anand, A.; Agarwal, M. A Goal Programming Approach for Agile-Based Software Development Resource Allocation. *Decis. Anal. J.* **2023**, *6*, 100146. [CrossRef]
109. Ben Brahim, I.; Addouche, S.-A.; El Mhamedi, A.; Boujelbene, Y. Cluster-Based WSA Method to Elicit Expert Knowledge for Bayesian Reasoning—Case of Parcel Delivery with Drone. *Expert Syst. Appl.* **2022**, *191*, 116160. [CrossRef]
110. Zadeh, L. Quantitative Fuzzy Semantics. *Inf. Sci.* **1971**, *3*, 159–176. [CrossRef]
111. Sahin, B.; Yip, T.L. Shipping Technology Selection for Dynamic Capability Based on Improved Gaussian Fuzzy AHP Model. *Ocean Eng.* **2017**, *136*, 233–242. [CrossRef]
112. Aruldoss, M.; Lakshmi, T.M.; Venkatesan, V.P. A Survey on Multi Criteria Decision Making Methods and Its Applications. *Am. J. Inf. Syst.* **2013**, *1*, 31–43.
113. U-Dominic, C.M.; Ujam, J.C.; Igbokwe, N. Applications of Analytical Hierarchy Process (AHP) and Knowledge Management (KM) Concepts in Defect Identification: A Case of Cable Manufacturing. *Asian J. Adv. Res. Rep.* **2021**, *15*, 9–21. [CrossRef]
114. Bai, C. Best-Worst Multi-Criteria Decision-Making Method: Some Limits and Improved Models. 2018. Available online: https://www.researchgate.net/publication/329372536_Best-worst_multi-criteria_decision-making_method_Some_limits_and_improved_models (accessed on 15 April 2024).
115. Pamučar, D.; Ecer, F.; Cirovic, G.; Arlasheedi, M.A. Application of Improved Best Worst Method (BWM) in Real-World Problems. *Mathematics* **2020**, *8*, 1342. [CrossRef]
116. Taherdoost, H.; Madanchian, M. Understanding Applications and Best Practices of DEMATEL: A Method for Prioritizing Key Factors in Multi-Criteria Decision-Making. *J. Manag. Sci. Eng. Res.* **2023**, *6*, 17–23. [CrossRef]
117. Triducive. Delphi Method Advantages and Disadvantages. 2024. Available online: https://triducive.com/2022/10/the-advantages-and-disadvantages-of-the-delphi-consensus-method/ (accessed on 15 April 2024).

118. Indeed. Delphi Method: Definition, Stages, Pros, Cons, Examples | Indeed.Com. 2024. Available online: https://www.indeed.com/career-advice/career-development/delphi-method (accessed on 15 April 2024).
119. Taherdoost, H.; Madanchian, M. A Comprehensive Overview of the ELECTRE Method in Multi Criteria Decision-Making. *J. Manag. Sci. Eng. Res.* **2023**, *6*, 5–16. [CrossRef]
120. Mark, V.; Thomas, H.P. An Analysis of Multi-Criteria Decision Making Methods. *Int. J. Oper. Res.* **2013**, *10*, 56–66.
121. Liu, S.; Lin, Y. *Grey Models for Decision Making*; Springer: Berlin/Heidelberg, Germany, 2010; pp. 197–223. [CrossRef]
122. Taherdoost, H.; Madanchian, M. Using PROMETHEE Method for Multi-Criteria Decision Making: Applications and Procedures. 2023. Available online: https://papers.ssrn.com/abstract=4464669 (accessed on 15 April 2024).
123. Vavrek, R.; Kotulic, R.; Adamisin, P.; Sira, E.; Vozarova, I.K. Effectiveness of Use of MCDM Methods in the Terms of Local Self-Government. In *Advances in Applied Economic Research*; Springer Proceedings in Business and Economics; Springer: Cham, Switzerland, 2017; pp. 279–288. [CrossRef]
124. Skiniti, G.; Daras, T.; Tsoutsos, T. Analysis of the Community Acceptance Factors for Potential Wind Energy Projects in Greece. *Sustainability* **2022**, *14*, 16009. [CrossRef]
125. Geka-Serpetidaki, P. Sustainable Siting of Offshore Wind Farms. Ph.D. Thesis, Technical University of Crete, Chania, Greece, 2024. Available online: http://hdl.handle.net/10442/hedi/56344 (accessed on 15 April 2024).
126. Gkeka-Serpetsidaki, P.; Tsoutsos, T. Integration Criteria of Offshore Wind Farms in the Landscape: Viewpoints of Local Inhabitants. *J. Clean. Prod.* **2023**, *417*, 137899. [CrossRef]
127. Gkeka-Serpetsidaki, P.; Papadopoulos, S.; Tsoutsos, T. Assessment of the Visual Impact of Offshore Wind Farms. *Renew. Energy* **2022**, *190*, 358–370. [CrossRef]