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Hidden movers in the wind farm: Functional stakeholders improving offshore wind development in Taiwan

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ABSTRACT

The increasing demand for clean energy has exacerbated conflicts between fishermen and offshore wind energy developers worldwide, particularly in coastal regions. This study explores the perspectives of fishermen, developers, and government authorities on offshore wind power (OWP) projects in Taiwan. Data were collected through direct observations at stakeholder workshops and semistructured interviews with key participants. Results highlight that fishermen prioritize sustaining fishing activities within OWP zones over relying solely on compensation. Effective engagement requires fishermen's associations to consult developers and officials. The key priorities include developing a coexistence plan for fisheries and OWP projects, establishing fair compensation standards, and implementing vocational training programs. Legislative support for spatial zoning within OWP waters under the national spatial plan is also critical. Finally, genuine consultations by fishermen's associations build trust, foster acceptance, and resolve conflicts, thereby accelerating OWP project progress. This study proposes an operational framework to enhance OWP policymaking, emphasizing that (1) functional stakeholders should establish an effective communication platform; (2) empathetic consultations can help developers prioritize stakeholders' livelihoods and coexistence strategies; and (3) legislative measures are essential for spatial planning, and compensation standards should be implemented by central authorities.

1. Introduction

Offshore wind power (OWP) holds immense potential for expanding global renewable energy supplies by reducing greenhouse gas emissions and combating climate change. This has led to the widespread adoption of policies that develop OWP globally, with successful models from the European Union, the United States, and Japan serving as key references [1]. However, OWP development encounters several barriers, including technological challenges, ecological impacts, social perceptions, and the need for stakeholder consensus [2–4]. For instance, in Canada, political and economic issues are the primary obstacles, while stakeholder disagreements and social perceptions play secondary roles [5]. Without effective stakeholder engagement, these barriers can substantially delay progress [6].

In Taiwan, OWP has emerged as a cornerstone of renewable energy efforts since 2010. In July 2011, the Taiwanese government launched the Thousand Wind Turbines Project, targeting 1200 and 5700 MW of onshore and offshore capacities, respectively, by 2025. This initiative aims for OWP to contribute 17% of the nation's total energy supply, with approximately 600 wind turbines planned for installation along the west coast. The 2018 OWP development plan designated waters off Changhua County as the primary area (Fig. 1).

The Taiwanese government outlined a three-stage development plan to achieve its energy supply goals (Table 1). Stage I focused on two demonstration wind farms, which were completed by 2020 and 2021. Stage II focuses on the regional development of 14 wind farms with a total capacity of 5500 MW, scheduled for operation in 2020–2025. Combined with Stage I, this would achieve approximately 5700 MW.

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Stage III targets zonal development, aiming for 15 GW (1.5 GW annually) in 2026–2035. However, as of 2024, only 2060.4 MW was operational, approximately 36% of the target—falling short of national energy policy objectives and socioeconomic needs.

Delays in OWP development stem from multiple factors, including the COVID-19 pandemic (2019–2021), but early setbacks were primarily owing to stakeholder conflicts. In July 2015, Taiwan's central government proposed a zoning plan with 36 potential wind farm sites to promote renewable energy policies. This was accelerated by the 2016 agenda for a nuclear-free Taiwan by 2025, aiming to increase the share of renewable energy from 5% in 2016 to 20% by 2025. However, insufficient stakeholder consultation during planning led to disputes among fishermen, government departments, and energy companies, hindering the establishment of wind farms. For example, the 2015 zones overlapped with cargo ship routes in the Taiwan Strait (red areas in Fig. 1) and aviation security zones (purple areas in Fig. 1), prompting

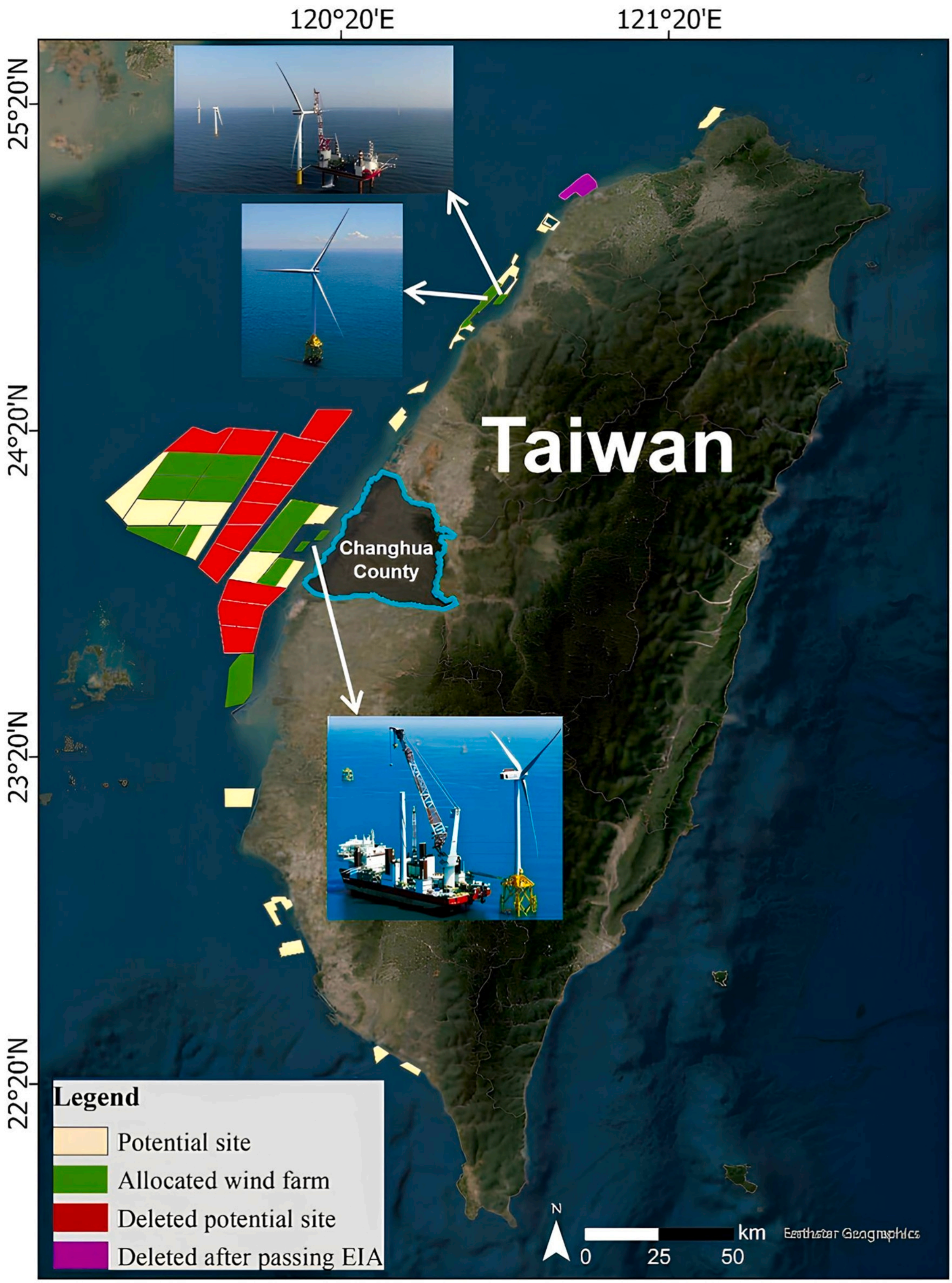

Fig. 1. Proven offshore wind farms in Changhua County, Taiwan (updated August 2024).

Table 1
Progress of OWP plans in Taiwan.

Stage	Wind farm No.	Capacity MW (Turbines)	Scheduled operation year	Condition in 2024
I	1	128 (22)	2018	In operation since 2020
	2	109.2 (21)	2020	In operation since 2021
II	3	376 (47)	2020	In operation since 2023
	4	640	2020	Trial operation
	5	605.2 (75)	2022	In operation since 2024
	6	294.8 (36)	2022	In operation since 2024
	7	451.2	2023	In operation since 2023
	8	300	2024	Trial operation
	9	96	2022	In operation since 2024
	10	300	2025	Under construction
	11	300	2025–2026	Processing
	11	232	2025–2026	Processing
	12	512	2025–2026	Processing
	6	337.1	2025	Construction started in May 2023 and is expected to be completed in 2025
	13	583	2025	Under construction
	14	570	2025	Processing
III	Zonal development			

objections from the Ministry of Transportation and Communications. Consequently, 12 sites were removed in 2018, delaying applications and underscoring the need for better stakeholder analysis in policy planning in addition to sufficient consulting of different departments within the central government. This lack of engagement highlights the importance of functional stakeholder involvement in resolving conflicts and accelerating OWP projects. This study draws on Taiwan's experiences to propose strategies for effective policymaking, emphasizing communication, empathy, and legislative support.

In Taiwan, the primary obstacle to OWP development is political pressure, as it forms a critical part of the energy policy supporting the decommissioning of four nuclear power plants by 2025. Moreover, OWP restricts traditional fishing activities, disrupting fishermen's livelihoods and sparking protests that hinder OWP development. Environmental protection groups have raised concerns about wind farm noise threatening the critically endangered humpback dolphin, a symbol of conservation along Taiwan's western coast. These dolphins are considered a green icon for environmental conservation against the exploitation of coastal wetlands by petrochemical institutes; however, it loses symbolic potency when the OWP is considered as green energy and local nongovernmental organizations urged the government to protect the dolphins [7]. Despite these challenges, Taiwan initiated a demonstration plan in 2015 and implemented spatial zoning for offshore wind farms 3 years after the 2012 national guiding plan. The government conducted limited assessments of environmental impacts, maritime navigation, and fisheries [8]. OWP development directly affects the commercial fishing sector by overlapping with traditional grounds, necessitating strategies to mitigate negative effects and promote coexistence among sectors, thereby increasing the acceptance of OWP development [9]. Resolving conflicts between fishermen and developers accelerates OWP advancement [10]. Thus, addressing fishermen's concerns as primary ocean users is vital for the successful implementation of OWP plans.

Taiwan's OWP policy, established in 2016, is irreversible yet faces resistance from stakeholders owing to inadequate consultation during decision-making. Poor communication and insufficient support measures have fueled protests against construction in the sea, which have hindered the progress of wind farm establishment, particularly over inadequate compensation and sediment resuspension affecting fish stocks. For instance, power companies were required to secure approval from local fisheries to ensure that wind power companies initially engage fishermen in associations, yet initial negotiations often failed, leading to on-site disruptions, such as frequent protest events against turbine construction because of inadequate compensation settlements and concerns regarding sediment resuspension caused by construction activities affecting fish harvests. This study proposes an operational negotiation and mitigation framework to address these conflicts in OWP policymaking. Potential cooperation strategies are investigated by focusing on the concentrated OWP planning in the west coast region of Changhua County (Fig. 1). The three primary objectives of this study are to (1) identify fishermen's primary demands, (2) evaluate effective negotiation strategies, and (3) develop a cooperation model that strengthens existing energy policies.

2. Materials and methods

This study integrated multidisciplinary expertise from coastal management, urban planning, and fisheries science to address conflicts between fishermen and energy companies in Taiwan's OWP development. Taiwan's OWP policy has been a top-down initiative that rapidly advances toward the national target of achieving an installed capacity of 5700 MW by 2025, often without adequate consensus from the fishing sector, leading to spatial and social tensions. A qualitative approach was employed to explore stakeholders' concerns and propose vocational transformation strategies for fishermen near the offshore wind farm in Changhua County. The research spanned 5 years (2017–2022) and involved targeted stakeholder collaboration. This research concentrated on enhancing strategies for the OWP policy executed via a top–down approach. Consequently, stakeholders were intentionally identified, including central and local authorities, fishermen and fisheries associations, energy companies, construction contractors, county legislators, and nearby residents. Table 2 summarizes the qualitative methods and data collection procedures.

2.1. Semistructured interviews

Social science approach is effective for examining the social aspects of energy transitions, such as perceived benefits, conflicts, and stakeholder attitudes toward renewable projects [11]. We conducted semistructured interviews with focus groups from July 2018 to 2022 to understand perceptions and experiences influencing support or opposition to OWP in Changhua County. This approach flexibly explored and compared emerging themes across participants [12]. Purposive sampling was used to select participants with relevant OWP experience and its impact on fisheries. This sampling technique is widely applied in qualitative research, allowing researchers to deliberately select individuals by providing rich, context-specific insights into the phenomenon under examination, further facilitating a deep understanding of the research problem [13–15]. Initially, participants included key representatives from OWP developers, energy companies, construction suppliers, and local fishermen who were actively engaged in consultation. A snowball sampling technique was subsequently adopted to further

Table 2
Qualitative research methods and data collection procedures.

Method	Purpose	Data collection procedure
Semistructured interviews	To explore perceptions, experiences, and negotiation strategies regarding OWP development and fisheries coexistence	Interviews were collectively conducted in response to the thematic questions (Table 3) and promote discussion related to cooperation, compensation, and vocational transformation.
Direct observation from stakeholder workshops	To capture real-time stakeholder interactions and consensus-building during OWP and fisheries negotiations	Researchers observed all workshops, recording field notes on communication dynamics, key issues raised, and discussion outcomes; supporting documents were collected from the CFA for further validation.

expand the sample and diversify the perspectives within the fishing community, in which initial informants recommended additional participants who met the inclusion criteria [16,17]. Two sets of semistructured interviews were conducted with 3 representative OWP developers, 3 representatives from energy companies, 4 construction suppliers, and 10 fishermen from Changhua County. The respondents were questioned based on various themes related to OWP-fisheries cooperation (Table 3). We also collected demographic data from the Changhua Fishermen's Association (CFA), including fishermen's age, education level, fishing gear type, and boat size, to assess their adaptability to OWP-aligned changes or vocational shifts.

2.2. Direct observation from workshops

Direct observation is widely used in qualitative research to capture stakeholders' perceptions and experiences related to social and marine issues [18–20]. It provides critical insights into interactions between focus groups, wind farm infrastructure, and policy implementation [20,21]. We conducted ethnographic observations at 22 workshops organized by the CFA from 2018 to 2022, involving >50 participants each. These workshops addressed conflicts between OWP development and fisheries, exploring strategies for fishermen's adaptation. Key participants included the chairman, director general, and secretary general of CFA, along with representatives from fishermen, central and local authorities, marine affairs researchers, and energy companies.

The main concerns raised included fishing prohibitions in OWP zones, socioeconomic impacts on fishing villages, and loss of traditional grounds. This feedback advanced negotiations and informed cooperation strategies for OWP and fisheries.

3. Results

In Taiwan, fishermen's associations focused on fostering cooperation between fishermen and related stakeholders, such as employees and government bodies. Fishermen can form councils authorized by the central government to manage fisheries, enhance livelihoods, and build skills. These councils often include nonfishermen staff for administrative tasks, including guidance for central and local governments. The CFA led most OWP-related workshops, drawing on the background data of archived fishermen for this study. Table 4 presents stakeholder perspectives from interviews and workshops, highlighting key findings on conflicts and solutions.

Table 3
Themes and questions for semistructured interviews.

Stakeholder	Theme	Questions
Fishermen	Fisheries economics	• What type of fishing gear do you use? • What is your average monthly income? • Which license do you have for fishing?
	Cooperation for OWP development	• Will you change your fishing gear as part of a collaborative effort with the OWP project? • Will you enhance your skills through training and work for OWP services? • What job opportunities are available for fishermen?
OWP company and supplier	Potential jobs for fishermen	• What salary does your company offer fishermen? • Which license is required to perform OWP services?
	Cooperation with fishermen	• Will your company release a portion of the OWP water for appropriate fishing gear? • If yes, does your company offer subsidies and training courses for fishermen?

Table 4
Stakeholder perspectives from interviews and observations in workshops.

Method	Interviewers/ Invited stakeholders	Key issue	Findings
Semistructured interview	• Representatives from OWP developers • Energy companies • Construction suppliers • Local fishermen	Trust formation	• Fishermen trusted the CFA to represent them in compensation negotiations. • Stakeholder consensus enabled the initiation of OWP construction in 2018. • Fishermen favored coexistence within the OWP zones, adapting fishing areas and gear rather than changing occupations. • OWP developers designated safe fishing zones and were committed to developing turbine-friendly fishing practices.
		Coexistence	• Younger fishermen showed interest in OWP employment if their wages were comparable with their current income. • OWP developers sought to train and employ local fishermen, but limited education and temporary job availability hindered long-term transitions.
Direct observation from stakeholder workshops	• Local fishermen • Central and local authorities • Marine affairs researchers • Representatives from energy companies	Ecological monitoring	• Fishermen raised concerns about ecological degradation and livelihood impacts near OWP sites. • Stakeholder workshops led to government-supported ecological monitoring and the establishment of fisheries compensation standards. • OWP developers are committed to funding ecological research and evaluating fishery impacts. The CFA served as a mediator, facilitating negotiations and consensus-building that enabled OWP construction.
		Coexistence	• Key members in the CFA claimed the need for a coexistence plan,

(continued on next page)

Table 4 (*continued*)

Method	Interviewers/ Invited stakeholders	Key issue	Findings
			particularly for small-scale fisheries. • Shellfish farmers feared siltation and habitat alteration caused by submarine cables.

3.1. Major concerns and solutions reported in stakeholder workshops

Stakeholder workshops on OWP development in Taiwan identified three primary concerns among fishermen. First, unclear financial compensation or subsidies for lost fishing rights and grounds created uncertainty. Second, noise and electronic devices from OWP infrastructure could degrade marine environments, habitats, and organism physiology, potentially reducing fishery resources. Third, fishermen were concerned about adapting fishing gear and transitioning to OWP-related vocations, highlighting the need for strategies to support the coexistence of traditional fisheries and renewable energy operations.

In Changhua County, the Fisheries Act granted exclusive fishing rights within three nautical miles of the coastline from 2009 to 2019, allowing CFA members to designate grounds for capturing and farming fish and shellfish. These rights restricted access to nonlocal fishermen and other sectors, intensifying conflicts with OWP development. Fishermen in the county are divided into two main groups: approximately 600 coastal capture and harvest of fish and shellfish for aquaculture purposes. However, these rights are exclusive to the CFA fishermen, prohibiting those from other counties and different sectors from accessing these waters.

During early 2012 workshops, capture fishermen claimed they were most affected, as their traditional grounds were near OWP zones (four nautical miles offshore), beyond their exclusive rights. They feared that construction noise and electronic disturbances would damage ecosystems and reduce fish stocks in adjacent waters. Shellfish farmers operating in tidal flats farther from OWP sites raised concerns about silt suspension from submarine cables, which could harm microalgae and shellfish growth. In response, developers were mandated to compensate, considering that the compensation amounts were determined by third-party consultants; however, a standardized formula for estimating these compensation amounts is yet to be established. Recognizing the critical relevance of compensating fishermen to promote OWP, Taiwan's negotiations stalled. In 2016, Taiwan's central government commissioned research to establish a compensation standard for fisheries affected by OWP projects. On November 30, 2016, an official compensation standard for fisheries impacted by OWP was released, factoring in the ratio of fishing rights areas to OWP zones. This framework aided negotiations and enabled OWP construction.

Another key issue was potential marine ecosystem damage. Capture fishermen planned to continue fishing despite losses, arguing that habitat destruction from construction would further limit their activities. Developers proposed using underwater power turbines and the surrounding protective rocks as artificial reefs to benefit fisheries, but fishermen remained skeptical and demanded evidence. CFA leaders advocated for scientific monitoring, leading the Bureau of Energy, Ministry of Economic Affairs, to fund a 4-year study on tidal flat habitats starting in 2017. Additionally, a developer initiated research on fish resources in OWP waters, ongoing until 2021. These projects provided data on ecosystem changes in marine ecosystems as well as potential strategies for transitioning fisheries in alignment with OWP development. During these initiatives, the CFA mediated among stakeholders to establish a consensus and expedite OWP development progress.

3.2. Potential coexistence between fisheries and wind energy

While compensation for lost fishing rights and marine ecosystem damage has been addressed through stakeholder communication, sustainable strategies for integrating OWP development and fisheries remain underdeveloped. This study used two questionnaires—one for fishermen and one for developers—to identify barriers and explore coexistence options.

Most capture fishermen in Changhua County use gillnetting with small boats (under 5 tons), while shellfish farmers (oyster and clam cultivators) work in tidal flats. Capture fishermen earn USD 1200–2500 monthly, compared with lower incomes for shellfish farmers. Capture fisheries require government licenses for vessel crews, unlike shellfish farming. These fishermen depend on OWP waters and are willing to shift from gill nets to less invasive methods.

According to 2017 records, Changhua has 612 fishing boats owned by 513 fishermen, with 97% being small (<5 tons) for gillnetting and 3% large (>15 tons) for trawling. Traditional gillnetting occurs up to five nautical miles offshore, while trawling 3–12 nautical miles, overlapping OWP zones and fueling protests. Fishermen preferred adapting changes in fishing grounds and gear over career changes, urging developers to allocate OWP areas for fishing. Older fishermen (>60 years) resisted transitions, stating "We expect the government to allow us to fish in the OWP waters. This is easier for us because we have been catching fish all our lives, and this is the best way to survive with OWP."

Meanwhile, a developer expressed concerns regarding marine spatial use for OWP development and fisheries:

"While the energy policy and OWP regions have been decided by the central government, as developers, we want to sincerely cooperate with the fishermen as much as we can. So, we have agreed to estimate the extent of open OWP water for fisheries. But, we have to ensure that all the fishing gear and approaches are not harmful to the wind turbines and the cables in the seabed."

The developers organize research projects focusing on monitoring the ecosystem and developing turbine-friendly fishing gear in OWP waters. Following a consensus, the first stage of OWP development off the coast of Changhua County commenced at the end of 2018.

3.3. Vocational transformation for fishermen

Younger fishermen under 50 years of age are open to considering work that does not involve advanced technology, provided that the salary meets their expectations:

"If fishing activities are prohibited, we will explore job opportunities related to wind power. We hope that energy companies will offer us a salary of approximately USD 1,500–2,500 per month because it would match our current standard of living."

Correspondingly, OWP developers and their associated companies have considered the potential in hiring fishermen:

"In our company, there are about 400 crew members working on trawlers across seven harbors in Taiwan. For OWP development, we are going to invest in barges and trawlers for the pipe construction and thus, will need more crew members in the near future. Our company will prioritize hiring local fishermen for new hires because they are well-versed with the waters around OWP areas. If local fishermen are willing to join us, we will provide them training and develop their skillset as much as possible, irrespective of their age."

Responses from developer companies and fishermen indicate that the following positions could assist fishermen in transitioning to OWP-related employment: guard boat crew members for monitoring ships around the construction vessel for safe navigation, marine mammal observers on the guard boat to look out for dolphins and halt construction work when marine mammals are present, and barge and trawler crew members for supporting construction.

Salaries range from USD 900 to 3000 based on task days, training required under the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, in addition to English skills for international teams.

Moreover, some companies require fishermen to possess strong communication skills in English because many developers and engineers in such companies are from abroad.

Only 94.4% (483 individuals) attended junior high school, whereas 5.6% (30 individuals) graduated from a college or university; this suggests that few fishermen possess the necessary education to effectively adapt to power generation technologies. Nevertheless, boat crew and observers are crucial for maintaining cooperative relationships between fishermen and OWP companies. Postconstruction, the need for observers and the demand for barge and trawler crew will decrease. Subsequently, only a small portion of the crew will transition to pipe-cleaning work.

4. Discussion

4.1. Fishermen's awareness of fishermen association's role

Taiwan's OWP policy is a public utility measure that enhances socioeconomic development. Achieving consensus among fishermen, who are key stakeholders, is critical for promoting development. Reportedly, a lack of stakeholder support poses a critical barrier to the implementation of effective energy policy [22–24]. Fishermen in Taiwan and Europe express concerns regarding compensation plans for their economic losses and the impact of noise on the ecosystem, spatial zoning, navigational safety, and transformation strategies [25–27]. These issues often stem from concerns and inadequate consultation in Taiwan and Europe [28,29].

Effective consultation builds trust among stakeholders and expedite development. The need for systematic consultation processes was highlighted during discussions with fishermen [30,31]; however, implementation involving several fishermen is not yet addressed. In Taiwan, under the Fishermen Association Act, fishermen's associations act as vital bridges between fishermen and developers, operating as government-supported entities. Fishermen must register with their local association and provide a personal information record. The government can collaborate with these associations to streamline the processes related to acquiring fishermen's insurance, renewing fishing licenses, and addressing considerable public issues. Accordingly, fishermen's associations will gain essential, granting them legislative authority and credibility. One fisherman noted:

"An official notice for the OWP policy was issued to us by the association and not the developers. Other relevant information on the fisheries from the central or local governments was also sent by the association. We trust the association to help the fishermen, particularly in the process of negotiating compensation."

In practice, associations streamlined negotiations by involving fishery leaders rather than all fishermen, enhancing communication and efficiently resolving conflicts. Interviewed fishermen highlighted the crucial role and satisfactory contributions of the fishermen's associations in raising awareness of the OWP project. The fishermen's associations enhanced communication and consultation quality, which expedited the resolution of conflicts between OWP developers and fishermen. However, workshops were organized and mediated through the fishermen's association, with interactions and outcomes shaped by intermediary coordination, issue framing, and facilitation aimed at supporting negotiation. This mediation enhances the feasibility of consensus-building but also indicates that workshops may function as stakeholder engagement tools designed to identify actions for specific aims, rather than fully capturing stakeholder perspectives [32]. Conducting multiple workshops on diverse topics may help mitigate these limitations.

4.2. Coexistence strategy under marine spatial planning (MSP) legislation

In Ireland, fishermen have embraced OWP jobs owing to exclusive fishing rights [33], contrasting with Taiwanese fishermen who protest OWP developments for threatening livelihoods. Developers in Taiwan typically use wind turbines manufactured overseas, which substantially hinders local fishermen regarding communication with international technicians and engineers. Lower education levels and a lack of professional skills obstruct fishermen's ability to seek new job opportunities [25,34–36]. A developer shared:

"The no-go zone around the turbines is about 50 meters and prohibits trawlers equipped with fishing net for the safety of the power equipment. However, our knowledge of fishing gear is limited, particularly regarding the types of fishing activists friendly to our wind power facilities."

Notably, trawl and gill nets could harm the turbine. Consequently, they proposed the use of environment-friendly gear, such as pole-and-line fishing or trap cages, within the OWP waters. The developers were committed to conducting research on this issue, which started in 2017 and was anticipated to be completed by 2023.

This study identifies recreational fisheries and marine tourism as potential options for Taiwan. For instance, designating areas near the turbines as prohibited zones can protect habitats and conserve resources. Additionally, the artificial reef effect created by constructing wind power facilities could benefit surrounding areas [24,35,37–39]. Consequently, small boats using gill nets can transition to pole-and-line fishing. Europe and the US are concerned about the visual impact of offshore wind turbines [40,41]. However, the Taiwanese fishermen anticipated an increase in the number of visitors intending to view the wind turbines. The popularity of turbine tourism at the first US offshore wind farm demonstrates that visitors arriving by ferry are impressed by the immense scale of the power generation infrastructure [42]. Therefore, fishermen can establish recreational fishing or ocean tourism activities, although these endeavors must adhere to higher safety requirements set forth by central government regulations. Although the coexistence plan is deemed reasonable, legislation for OWP water management institution remains unclear. A developer made the following statement:

"It is possible to release water between the turbines while maintaining a buffer zone from the foundation for fishing, but this depends on the laws and regulations in Taiwan. Some major questions are who has authority over spatial zoning and who is responsible for enforcement in OWP waters. We have to make sure that the wind turbines remain safe along with any fishing activity."

In response, the central government stated that under the Spatial Planning Act of Taiwan (2016), the national spatial plan will stipulate OWP water management in marine resource zones classified as types 1 and 2. In these zones, the use of OWP water, extending from the surface to the seabed, should be strictly controlled to prioritize human activities. However, Article 45 of the Spatial Planning Act specifies that the national spatial plan must be announced by the central authority within 2 years of the Act taking effect. Since July 2019, the plan is under negotiation with stakeholders and critically behind the scheduled publication timeline. Nevertheless, this represents only one approach for implementing spatial zoning for fisheries in OWP waters through legislative support.

A coexistence plan has significant potential and should be considered by the central government and developers. At this stage, MSP will expedite the advancement of OWP development policies and enhance the land use policies of the central government. This study highlights that legislative support for coexistence, including spatial zoning and ecofriendly practices, addresses barriers and aligns with global strategies.

4.3. Determining functional stakeholders

Stakeholder theory defines stakeholders as groups or individuals who can affect or be affected by an organization's actions [43]. Mitchell et al. [44] introduced a model to assess stakeholder salience based on power, legitimacy, and urgency attributes, which has informed collaborative efforts in various fields. This approach, while originally for organizational management, extends to environmental policy, such as healthcare priority setting [45] and marine conservation [46,47]. However, Duggan et al. [48] proposed an evidence-based method to categorize functional stakeholders by quantifying interests in management objectives (e.g., Yield, Employment, Profit, and Ecosystem Preservation), revealing common interests but limited evidence of effective negotiation across groups. In ecosystem-based fisheries management, stakeholders include those influencing or affected by policies, such as scientists, managers, and fishermen, yet specialist-driven regulations may not align with fishermen's needs [48]. The study findings underscore the gap: while scientists and managers provide expertise, fishermen require localized interpretations, as highlighted by CFA leaders advocating for marine ecosystem monitoring (Section 3.1). Effective communication bridges scientific data and local knowledge.

For environmental policies and the advancement of renewable energy, stakeholder analysis predominantly helps execute decisions or objectives. For instance, Reed et al. [49] utilized an interest–influence matrix along with the relationships among stakeholders for identifying distribution patterns concerning various stakeholder attributes in managing natural resources. Although literature predominantly emphasizes methods for classifying stakeholders based on their influence, quantifying effective communication is challenging. Herein, the CFA leaders in the workshops revealed the ability to interpret social demands and promote communication among stakeholders using a shared language.

Concerning public policy/action implementation viewpoint, a broadly defined stakeholder included in this planning may increase the complexity and difficulty of forming a consensus, whereas salience stakeholders should be identified and engaged during the incremental negotiations stage. Functional stakeholders promote consensus in decision-making amidst competing knowledge and usage claims. Nevertheless, functional stakeholders are not exclusively associated with a specific group (such as fishermen's associations or environmental protection organizations) but rather pertain to those who possess the capability for effective communication. For instance, research on the just transition for fisheries amid the renewable energy development in Scottish waters revealed that fisheries liaison officers or intermediary parties can serve as a conduit to promote effective communication and trust among stakeholders [50].

Finally, functional stakeholders should be designated as those who perform a processual mediating role through communicative capacity to interpret social demands, translate specialized knowledge into actionable claims, and facilitate shared understanding across stakeholder groups within policy decision-making, management planning, and institutional amendment processes, as revealed in Fig. 2.

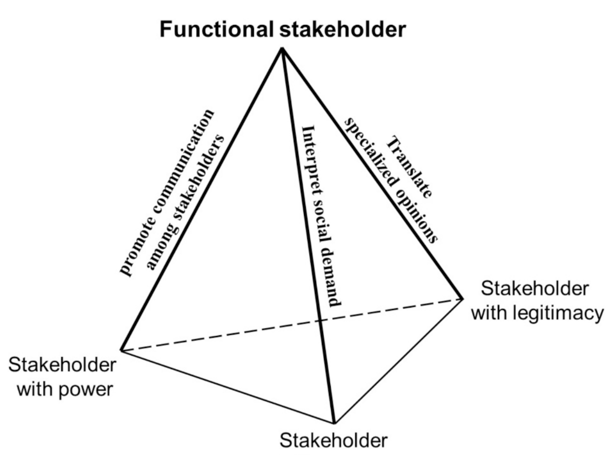

Fig. 2. Core capacities of functional stakeholders strengthening three key attributes (modified from [44]).

As illustrated in Table 4, fishermen's urgent livelihood concerns did not automatically translate into policy influence; rather, their salience emerged through trust-based mediation by the CFA, which enabled these demands to be coherently articulated and institutionally recognized. Similarly, coexistence strategies within OWP zones gained legitimacy not merely through stakeholder participation but through the CFA's ability to translate localized fishing practices and experiential knowledge into policy-relevant terms that authorities and developers could understand and operationalize. Ecological monitoring demonstrates that scientific expertise alone was insufficient to influence decision-making, but acquired legitimacy and governance relevance through functional stakeholders who translated specialized knowledge by aligning scientific evidence with fishermen's concerns and prevailing regulatory expectations.

These findings indicate that functional stakeholders possess more than just salience attributes; they operate at the interface, emphasizing communication, translation, and trust-building as critical processes through which urgency becomes communicable, legitimacy is socially reinforced, and power is exercised indirectly through consensus-building.

4.4. Operational framework to improve OWP policy

MSP effectively supports projects like OWP by balancing ecosystem conservation, the exclusive use of marine space, and economic growth through early stakeholder engagement [51,52]. In Europe, MSP successfully integrates sector drivers, but Taiwan's OWP policy prioritizes scientific site selection over communication, resulting in conflicts with conservation groups and fishermen. The study findings reveal that fishermen's associations mitigated these issues by organizing workshops and providing recommendations, enhancing MSP implementation. We propose an operational framework (Fig. 3) to guide OWP policymaking. The proposed framework identifies functional stakeholders that integrate theoretical definitions and implementation. From Fig. 2, the rationale for functional stakeholders should start with a broad definition of affect/affected interest. Then salience stakeholders could be identified according to their supportive attributes [44,48,49].

The proposed operational framework contrasts with earlier offshore wind governance experiences, such as the Cape Wind project in the United States, which ultimately failed to materialize due to prolonged stakeholder opposition, regulatory delays, and politically mobilized public controversy [53,54]. In contrast, the Taiwan case demonstrates how functional stakeholders can facilitate communication between livelihood-based social concerns, coexistence strategies and policy processes, thereby helping to mitigate conflict escalation during MSP. A comparable yet successful governance trajectory can be observed in the Block Island Wind Farm (BIWF) experience in the United States, where relatively higher levels of public acceptance were achieved through an early participatory planning process, combined with frequent informal interactions among developers, public authorities, and affected interest groups throughout the project permitting stage, allowing sectoral concerns to be addressed before conflicts became entrenched [55]. Additionally, Howley et al. [56] indicated that offshore wind planning processes lacking effective communication and trusted channels were particularly vulnerable to misinformation and conflict escalation. This underscores the importance of intermediary engagement and communicative mediation emphasized in our framework.

4.4.1. Communication platform by functional stakeholders

A key factor in OWP development is achieving consensus between developers and fishermen. The CFA is ideally positioned to lead workshops that facilitate negotiations among fishermen and other stakeholders. Japan's OWP progress, driven by fishermen's support and compensation negotiations through associations, highlights this functional role [57].

Public relations theory views stakeholders as individuals or groups

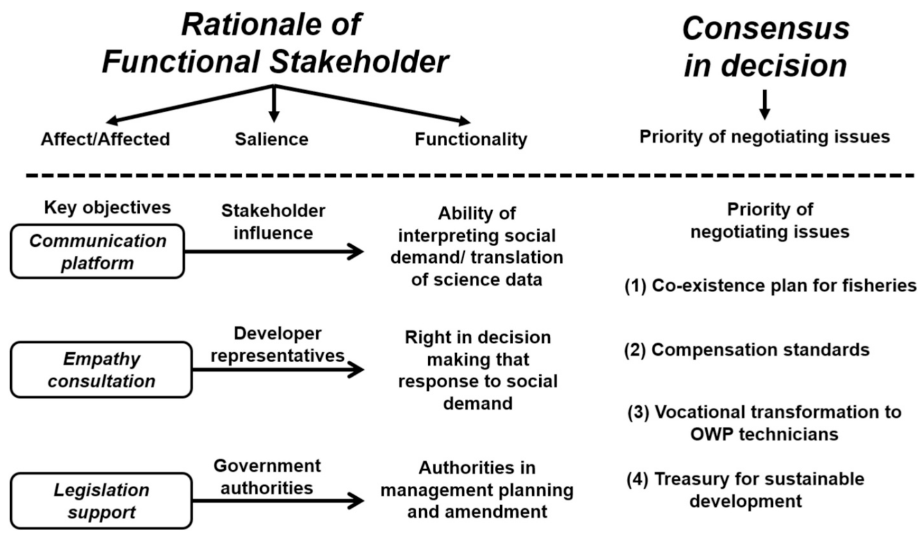

Fig. 3. Operational framework to improve OWP policymaking.

providing input to organizations and output to governments and communities [58]. Functional stakeholders ensure ongoing communication, with organizations holding moral and legal responsibilities to prioritize them [59]. This study identifies three key functional stakeholders in fishermen's associations: the chairman (a voluntary, elected fisherman), the director general, and the secretary general (professional, non-fishermen administrators hired by the council and dependent on the organization for their roles) [60]. Observations showed that the chairman managed fishing opportunities in OWP waters and compensation for resource losses, while the director general and secretary general addressed livelihood needs and vocational gaps. They offered constructive advice to fishermen and developers:

"The developers should realize that the compensation amount for fishermen cannot support them in the long run, particularly if they exit the fisheries sector without developing alternative skills. Thus, we have suggested fishing activities within the OWP waters as a short-term strategy for the elderly fishermen and vocational transformation for the younger generation as a long-term measure."

Most CFA suggestions were adopted, demonstrating how functional stakeholders prioritize barriers to enhance negotiation efficiency and public interest communication.

4.4.2. Empathy consultation

In workshops, fishermen prioritized maintaining fishing activities in OWP waters over compensation, whereas developers considered budgets as a major obstacle. A developer's research showed that addressing livelihood uncertainties eases negotiations, with 28.5% of fishermen opposing OWP, 26% supporting it, and 45.5% conditionally agreeing under a coexistence plan [61]. Fishermen fear displacement by turbines, as smaller fleets limit access to alternative waters. Yates et al. [62] stressed incorporating colocation during zoning to reduce fishery costs, whereas Bonsu et al. [63] highlighted the potential for passive fisheries (e.g., pots and traps) in the North Sea wind farms. Withouck et al. [50] reported that restricted participation by smaller fishing fleets during Scottish offshore wind farm developments has hindered just transition; on the contrary, fishermen with small-scale vessels expressed concerns that additional OWP projects would lead to loss of fishing grounds, making the compromise reluctant. In parallel, most fishermen within our study region manage small-scale coastal fleets with navigation restricted to six nautical miles, thereby limiting their ability to fish beyond traditional waters. Thus, stakeholder empathy consultation is needed for effective planning of ocean renewable energy policy.

Initially, the planning of the wind farm in western Taiwan excluded stakeholder engagement, resulting in the adaptability of small-scale fisheries being overlooked. Consequently, during workshops, some fishermen and key CFA members expressed support for fishmen's livelihoods (Sections 4.2 and 4.4.1). Meanwhile, fishermen advocated for coexistence strategies within the offshore wind farm to aid in OWP development and sustainable fisheries growth. On December 21, 2018, the central government responded to the fishermen through the Application Review Committee of Coastal Management, requiring OWP developers to submit a plan for the wind farm areas. This implies that OWP developers are responsible for coastal management, particularly for the coastal zones they intend to use. Developers should proactively assist in the planning of sea ranching sectors once fisheries authorities decide to proceed.

Sea ranching enhances fish resources by introducing hatchery or wild juveniles into specific marine environments wherein they can grow without containment structures. Herein, local oyster farming could be transitioned into the waters surrounding wind farms, which may provide bait and habitat for smaller organisms attracting fish schools to the area. Therefore, fishermen can continue fishing in environment-friendly gear while potentially increasing their income compared with current levels. Therefore, a realistic model for a coexistence plan should prioritize negotiation strategies to address concerns regarding the loss of fishing grounds. This study provides empirical evidence on the impact of empathy consultation, including communications on understanding and support for social demand as a result of the implementation of management amendments.

4.4.3. Legislative support

OWP projects are central to Taiwan's energy policy, but fragmented legal frameworks hinder marine spatial management, creating a regulatory vacuum [20,64]. Conflicts are resolved through ad hoc negotiations without specific MSP legislation, burdening local actors such as fishermen's associations [65]. This situation reflects an asymmetrical power structure, wherein the central government promotes rapid OWP expansion to meet national energy goals while devolving the socio-spatial burdens of conflict resolution onto local actors. Consequently, the state functions as a fragmented and politically motivated institution rather than a neutral arbiter, with its ministries pursuing divergent priorities and economic incentives during energy transition [20].

A robust legislative framework is needed to coordinate ministries, clarify zoning authority, and mandate early stakeholder engagement [51]. OWP executives should incorporate fishermen's needs into strategies, such as establishing funds for fishing village development, including education and job programs. Regulations could require developers to contribute to these funds, ensuring long-term sustainability.

5. Conclusions

Functional stakeholders within fishermen's associations should establish an efficient communication platform to ensure effective fisheries management and accelerate OWP development. Workshops conducted by fishery leaders are instrumental for addressing the loss of fishing grounds and the impact on marine ecosystems, while providing an opportunity for fishermen to express their opinions. This genuine consultation has fostered trust, acceptance, and support among fishermen and developers. The concept of functional stakeholders developed in this study contributes to broader debates on MSP, communicative governance, and energy justice. Theoretically, it advances stakeholder theory by shifting the focus from static salience attributes to processual mechanisms, including communication, knowledge translation, and trust-building, through which influence and legitimacy are generated. From a policy perspective, the findings demonstrate how coexistence-oriented strategies can be supported by intermediary actors, thereby reducing conflict escalation in offshore wind governance. The proposed operational framework can be applied to the implementation of other public policies, wherein functional stakeholders can provide a communication platform and realistic consultations prioritizing key issues. The first step in negotiating remedial strategies is identifying stakeholders and understanding their livelihood conditions. For instance, wind turbines may disrupt marine resources, which further makes fishing in waters near wind farms more pressing than vocational transformation. Furthermore, technical training for OWP services should be included as part of the compensation plan for fishermen. Scholarships under a systematic education plan encouraging younger generations in fishing villages represent a sustainable strategy for fisheries and renewable energy.

CRediT authorship contribution statement

Yi Chang: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Yi-Ping Hung:** Visualization, Validation, Methodology, Investigation, Formal analysis. **Tung-Yao Hsu:** Visualization, Validation, Software, Investigation, Data curation. **Jen-Han Yang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Formal analysis. **Wei-Ju Huang:** Visualization, Validation, Supervision, Methodology, Investigation, Conceptualization. **Liang-Chin Chi:** Visualization, Validation, Investigation, Formal analysis. **De-Jung Chen:** Visualization, Validation, Supervision, Investigation, Formal analysis.

Declaration of competing interest

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Data availability

Data will be made available on request.

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