ADDRESSING THE WICKED PROBLEM OF ENERGY POLICY: A DATA-DRIVEN APPROACH USING THE ANALYTIC HIERARCHY PROCESS IN AQUAVOLTAICS POLICY OF TAIWAN

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ABSTRACT
This study explores the challenges of implementing the aquavoltaics policy in Taiwan, a classic example of a ‘wicked problem’ in energy policy due to its complexity and the diverse interests involved. Utilizing the analytic hierarchy process (AHP), the research enhances the Solar Fishery and Electricity Symbiosis Auditing Environmental and Social Inspection (SFES-ESI) framework, effectively bridging the gap between policy planning and stakeholder expectations. The AHP methodology facilitates a systematic and objective evaluation of key issues, enabling stakeholder participation and minimizing emotional biases. It helps in the effective management of conflicts, improvement of communications, and refinement of policies. Detailed AHP analysis reveals that social considerations are paramount (31.9%), followed by environmental (28.1%) and economic factors (24.3%), highlighting the need for a balanced approach that aligns solar energy policies with local values while promoting sustainable economic and environmental development. This approach provides a strategic, data-driven framework for addressing energy policy challenges in Taiwan, emphasizing multi-faceted policy-making and stakeholder engagement in sustainable development.
Keywords: aquavoltaics, analytic hierarchy process (AHP), wicked problem, public participation, energy policy, policy decision making, green conflict.

1 INTRODUCTION

The landmark Paris Agreement of 2015 [1] marked a pivotal moment in global efforts to combat climate change. This historic accord, embraced by nations worldwide, set the ambitious goal of achieving net-zero emissions by 2050 [2], signalling a shared commitment to a sustainable future. The urgency and complexity of developing effective energy transition policies have since become a focal point of international discourse, underscoring the necessity for governments to balance carbon reduction targets with the rights and responsibilities of future generations [3].

Taking Taiwan’s aquavoltaics plight as an example, the rapid development and application of renewable energy technologies have sparked significant local opposition and resistance [4], which largely contributed to the solar PV installation targets falling short of expectations by over 29%. Local resistance is not solely driven by the ‘not in my backyard’ phenomenon, aimed at protecting personal or various social interests. It encompasses a broader range of factors including value systems, concerns over local environmental ecology, and questions of justice in planning and benefit distribution [5]. Energy policy, therefore, encompasses multiple dimensions such as environmental, social, and economic aspects. Different perspectives on energy development lead to diverse and sometimes conflicting positions and viewpoints [6]. These diverse viewpoints can either be interconnected or conflicting, epitomizing the essence of what is termed a ‘wicked problem’ – complex and ill-structured problems that are difficult to define, with multiple interrelated causes and effects, and often lacking a clear solution [7]. Thus, conflicts may arise even among proponents of

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environmental conservation under certain circumstances. This phenomenon is referred to as the 'green on green controversies' [8], a term that encapsulates the conflict between the environmental goal of fighting global climatic changes and other crucial environmental concerns [9].

Communities' acceptance of new energy systems is crucial for the success of renewable energy policies [10], [11]. Traditional top-down approaches in policy formulation often overlook public preferences, leading to local resistance [5], [12], [13]. This local resistance can cause significant delays, threatening the achievement of projects and the effective implementation of policies aimed at promoting renewable energy [11]. Shindler et al. [14] emphasise that policies which focus solely on rational technical and scientific aspects, while ignoring public concerns, are likely to struggle in gaining public acceptance [15]. Therefore, public participation is important as involving the public in the decision-making process can effectively reduce conflicts among stakeholders and facilitate smoother policy implementation [16].

Hence, recognizing the significance of public involvement, multiple-criteria decision making (MCDM) becomes a pivotal approach in energy policy planning (energy policy decision making (EPDM)) [12]. MCDM is particularly valued for its ability to consider multiple perspectives simultaneously in the context of energy policy. Within the realm of MCDM methods, the analytic hierarchy process (AHP) stands out [17]. AHP can accommodate the conflictual, multidimensional, immeasurable, and uncertain effects of decisions among various stakeholders. It standardizes public participation in decision-making, enhancing the processes transparency and credibility [18]. By providing a clear and objective decision-making framework, AHP helps build trust and understanding among different parties. It aids in reducing perceptions of bias and ensures that all voices are heard and considered [19].

Conflicts often arise when the policy planning and implementation approaches of decision-makers fail to align with the perspectives of on-the-ground implementers and local communities [4], [20]. Therefore, focusing on Taiwan's aquavoltaics practices, the study is aimed to enhance policy alignment and execution by engaging relevant stakeholders in a collaborative decision-making process. It seeks to articulate the diverse values and considerations of these stakeholders in a data-driven manner, thereby improving communication and mutual understanding. Ultimately, this participatory approach is designed to facilitate the successful implementation of policies and the attainment of their intended objectives.

In addition to a brief introduction regarding the aquavoltaics policy and practices in Taiwan, this paper will articulate the theoretical foundations of the AHP and the survey design employed in this study. Then, the result and related discussion of an empirical study is provided and finalized with concluding remarks.

2 AQUAVOLTAICS POLICY IN TAIWAN

On June 15, 2015, in the post-Kyoto era, Taiwan formally incorporated the goal of 'reducing GHG emissions to no more than 50% of 2005 GHG (Greenhouse Gas) emission by 2050' into the 'Greenhouse Gas Reduction and Management Act' (renamed the 'Climate Change Response Act' and its objective was revised to 'achieving GHG net-zero emission by 2050'). To attain this goal, in 2016, Taiwan implemented a policy titled 'a plan to promote an innovative industrial ecosystem for green technologies' [21], aimed at facilitating the country's energy transition.

In response to climate change and to reduce dependency on energy imports, this policy has outlined a series of goals and proactive measures focusing on 'energy creation' [22].

Among these, the plan includes achieving a solar photovoltaic (PV) generation capacity of 20 GW by 2025, which is divided into 17 GW from ground-mounted solar PV and 3 GW from rooftop solar PV [23].

Taiwan, located in the subtropics with minimal sunlight obliquity and long sunshine hours, considers ground-mounted solar PV systems a crucial measure in its green energy development strategy [24], [25]. However, the development of large-scale ground-mounted solar PV faces challenges due to the high population density, limited land area and land fragmentation [24]. To address this issue, Taiwan has prioritized 'aquavoltaics', a dual-use land approach by integrating fisheries and electricity generation [26], as a key strategy of its solar PV development.

During the development of solar PV, the generation target for ground-mounted PV was initially set at 17 GW but was adjusted to 14 GW in 2020 [27] and further reduced to 12 GW in 2021. The primary reason for these successive reductions was the local resistance and conflicts opposing aquavoltaics, which led to the stagnation of the aquavoltaics policy [28], [29]. This situation underscores the importance of smooth communication between the government and stakeholders which, along with early public involvement in decision-making [30], is crucial to avoid the adverse impacts of local resistance on projects.

In response to public concerns, the government has introduced the Solar Fishery and Electricity Symbiosis Auditing Environmental and Social Inspection (SFES-ESI) before ground-mounted PV farm development. SFES-ESI aims to prevent negative environmental and ecological impacts from solar farm installations and ensures the rights of stakeholders through public participation in social and economic aspects.

Although aquavoltaics policy includes SFES-ESI to ensure public participation, it faces similar criticisms as the general social assessment process. Stakeholders often feel that their involvement in the communication process is insufficient [18]. The methods used in SFES-ESI, such as community workshops, public meetings, and interviews, are traditional and tend to be perceived more as means for 'information gathering' rather than 'participation in decision-making' [15]. Given the diversity, complexity, and even conflict of viewpoints among stakeholders in energy policy, the outcomes under such methods often appear as an all-or-nothing concept. This means that the parties whose views align with the policy may consider the communication effective. However, those whose views differ may feel their perspectives are unprotected and unacknowledged, leading them to question the effectiveness of stakeholder communication.

Obviously, that traditional stakeholder communication methods do not adequately include stakeholders' views in final decision-making, nor clarify why certain decisions are made. In turns, the following improvements become necessary:

- Identify and analyse the priority of public concerns and values and compile them into factors that could impact the implementation and success of the policy, while also building a local hierarchy framework of aquavoltaics in Taiwan.
- Integrate the AHP method with the existing SFES-ESI to facilitate the amalgamation of stakeholder and decision-maker perspectives. This integration aims to identify and address areas of conflict early in the process.

3 MATERIALS AND METHODS

3.1 Problem definition and research framework

This study aims to develop a local hierarchy framework to identify and analyze factors influencing the successful implementation and achievement of the 'Balancing Green Energy, Fishermen's Rights, and Public Opinion' goals in the aquavoltaics policy. As energy policy involves value judgments and represents an intractably 'wicked problem' [8], it necessitates a rigorous process that classifies and discusses issues without involving stakeholders' emotions [19]. By doing so, this study seeks to efficiently manage conflicts, enhance communication, and assist in policy improvement.

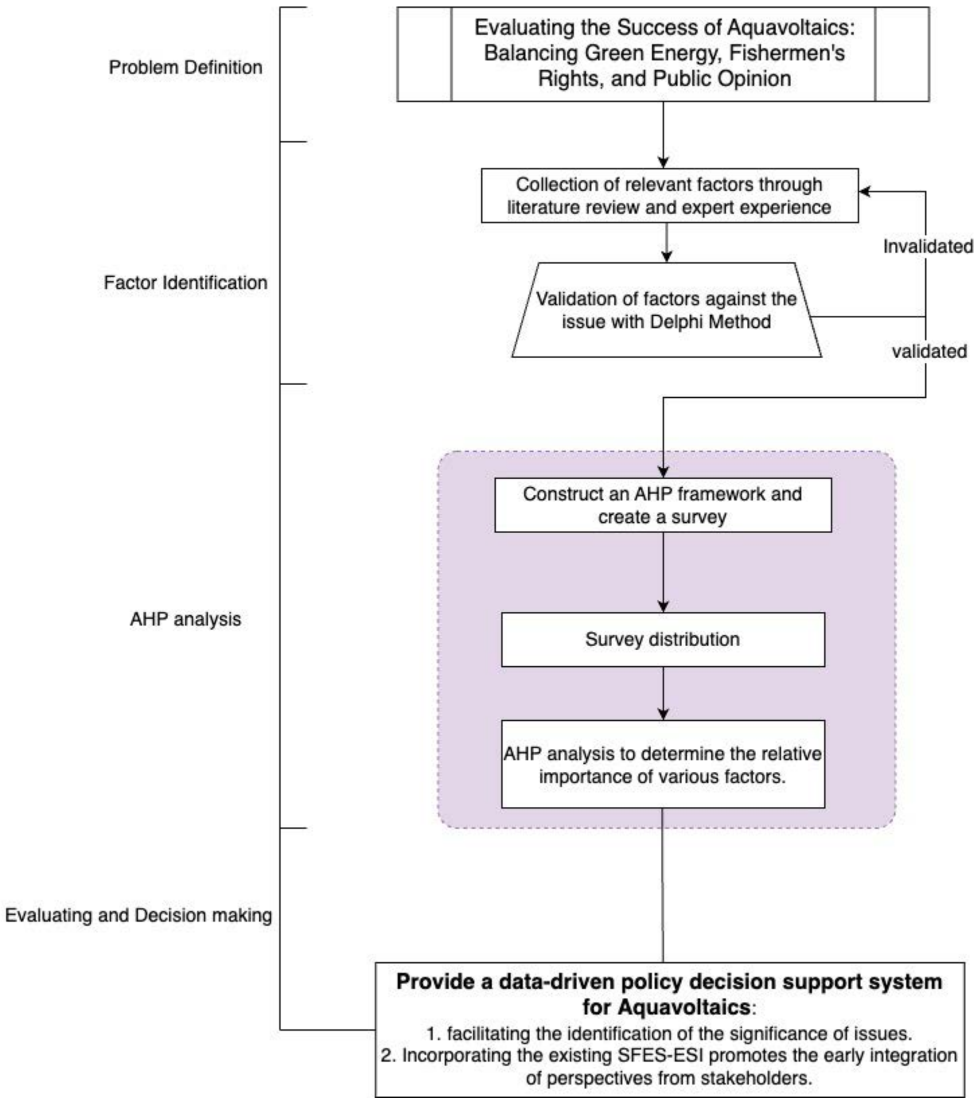

Figure 1: Research framework.

3.2 AHP

Saaty [31] introduces the AHP as a quantitative analysis method designed to assist decision-makers in making flexible decisions driven by data. The main idea of AHP is structured by evaluating the relative importance of different decision factors. A key advantage of AHP is the ability to handle MCDM problems and its applicability in various decision-making scenarios. Key points to consider in constructing and analysing the hierarchical structure include:

- The highest level represents the overall goal of the evaluation.
- Factors under the same goal should be as close in importance as possible.
- To ensure consistency in hierarchy, the number of attribute factors under a fundamental goal should be less than seven and these factors should be mutually independent.

Once the AHP structure rules are established, the calculation method is further explained in four steps.

3.2.1 Construction of a pairwise comparison matrix

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nn} \end{pmatrix}. \tag{1}$$

where a_{ij} represents the relative importance between two factors.

3.2.2 Normalization of the pairwise comparison matrix
The matrix is normalized by dividing each row by its sum, ensuring the sum of elements in each row equals one, which brings consistency in comparisons among different factors.

$$S_j = \sum_{i=1}^{n} a_{ij} \text{ for each column j} \tag{2}$$

$$\widetilde{A} = \begin{pmatrix} \frac{a_{11}}{S_1} & \frac{a_{12}}{S_2} & \frac{a_{13}}{S_3} & \cdots & \frac{a_{1n}}{S_n} \\ \frac{a_{21}}{S_1} & \frac{a_{22}}{S_2} & \frac{a_{23}}{S_3} & \cdots & \frac{a_{2n}}{S_n} \\ \frac{a_{31}}{S_1} & \frac{a_{32}}{S_2} & \frac{a_{33}}{S_3} & \cdots & \frac{a_{3n}}{S_n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{a_{n1}}{S_1} & \frac{a_{n2}}{S_2} & \frac{a_{n3}}{S_3} & \cdots & \frac{a_{nn}}{S_n} \end{pmatrix} \tag{3}$$

where S_j represents the sum of each column and $\tilde{A}$ represents the normalized matrix.

3.2.3 Calculation of factor weight vector
Using the largest eigenvalue method on the normalized matrix A', the weight vector *w*, representing the relative importance of each factor, is calculated.

3.2.4 Consistency test

Check the consistency of the pairwise comparison matrix using a consistency index. If this index exceeds a predefined threshold, adjustments or re-evaluations are needed.

The consistency index (CI) is formulated as in eqn (4), where λmax represents the largest eigenvalue and n is the number of factors.

$$\mathrm{CI} = (\lambda\mathrm{max} - n)/(n - 1). \tag{4}$$

Subsequently, the consistency ratio (CR) is calculated as in eqn (5), with RI referring to the random index.

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}. \tag{5}$$

This research utilizes the consistency ratio (CR) as a barometer for validation. A CR value below 0.1 is indicative of acceptable consistency within the comparison matrix, thus endorsing the reliability and coherence of the AHP computational outcomes.

3.3 AHP survey design

In this study, the AHP survey was structured using the SurveyCake online survey system [32]. The assessment of importance levels within AHP (ranging from extreme, very important, etc.) is based on the pairing of attributes along the X and Y axes. The positioning of the checkbox closer to the X attribute indicates a higher importance of that attribute over the Y attribute, and vice versa.

The survey is divided into two distinct parts. 'Part 1 – Criterion comparison' involves pairwise comparisons between four core criteria: social, economic, environmental, and development. 'Part 2 – Factor comparison' consists of pairwise comparisons of factors under their respective criterion. For the 'social' and 'development' groups, there are additional sub-factors to be compared, leading to a more detailed analysis within these categories. The survey includes a total of 16 primary factors, with additional sub-factors under the 'social' and 'development' categories. The survey design incorporates sliders for respondents to make their selections, an example of which is illustrated in Fig. 2.

A	A is absolutely more important		A is strongly more important		A is moderately more important		A is slightly more important		A and B are equally important		B is slightly more important		B is moderately more important		B is strongly more important		B is absolutely more important	B
	9 : 1	8 : 1	7 : 1	6 : 1	5 : 1	4 : 1	3 : 1	2 : 1	1 : 1	2 : 1	3 : 1	4 : 1	5 : 1	6 : 1	7 : 1	8 : 1	9 : 1	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	

Figure 2: Example of SurveyCake AHP survey.

4 EMPIRICAL STUDY

4.1 Decision objectives and factor design

In the factor identification step, this study ascertained the key factors that could influence the successful implementation of aquavoltaics in Taiwan. This process involved (1) the collection of relevant factors through a comprehensive literature review and the consolidation of expert experiences; and (2) the validation of these factors in relation to the practical issues at hand using the Delphi method. Based on the AHP criteria established, the study constructs the AHP framework as depicted in Fig. 3.

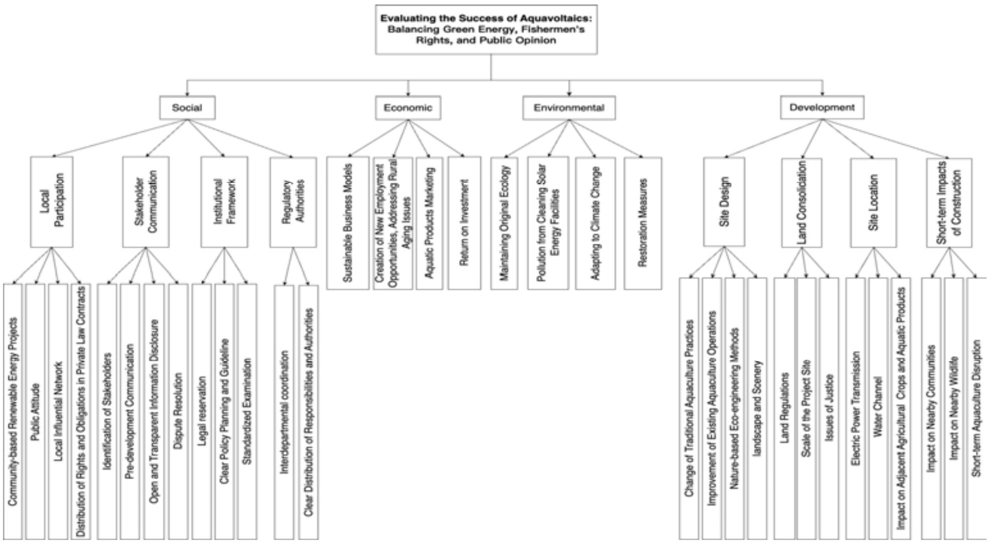

Figure 3: AHP structure.

4.2 Results of the AHP survey

In this empirical study, the AHP survey was completed by 30 experts from diverse sectors that encompasses political, economic, aquaculture, environmental, and energy sectors, ensuring a comprehensive range of perspectives.

The distribution of respondents' background revealed that most respondents were from the academic and photovoltaic sectors, each accounting for approximately 29.17%. This was closely followed by the government sector, representing 20.83% of the respondents. The aquaculture sector comprised 12.5%, while the environmental sector and other categories each held a smaller share of 4.17%.

Based on the outcomes of the analytic hierarchy process (AHP) survey, this study utilized the AHP-OS platform [33] for the computation and analysis. The AHP survey facilitated the determination of the weights of criterions and the local priorities of various attribute factors under each criterion as well as the global priorities of each attribute factor.

Moreover, the survey underwent a rigorous consistency test. The consistency ratio (CR) values obtained in different sections of the survey indicated robust consistency. Specifically, the overall goal questionnaire yielded a CR of 0.043, while the 'social' criterion had a CR of 0.044, the 'economic' criterion had a CR of 0.022, the 'environmental' criterion had a CR of 0.03, and the 'development' criterion had a CR of 0.004. The results from different nodes (tasks) uniformly passed the consistency test. Consequently, the validity of the questionnaire was affirmed.

4.3 Analysis of AHP factor importance

4.3.1 Criterion comparison

In the criterion comparison, the results indicate that 'social criterion' (0.319) is the most important objective, followed by 'environmental criterion' (0.281), 'economic criterion' (0.243) and then 'development criterion' (0.157), as illustrated in Table 1. This means that the paramount importance of 'social criterion' indicates that the success of the project relies not merely on its technical and economic feasibility, but also largely depends on social acceptance and community support. The significance of 'environmental criterion' considerations highlights that the sustainability of the project and its impact on the ecosystem are critical factors to be addressed.

Table 1: Criterion comparison results.

Level 1	**Result**
Social	0.319
Economic	0.243
Environmental	0.281
Development	0.157

4.3.2 Factor comparison

For the factor comparison, the results highlight 'adapting to climate change' as the most significant factor, with a weight of 0.119425. This emphasizes the critical role of aquavoltaics in climate change adaptation and mitigation, showcasing its importance in global carbon reduction efforts through alternative energy sources.

Following in significance are 'institutional framework' and 'stakeholder communication'. With a weight of 0.093467, 'institutional framework' underscores the necessity of having clear laws and policies, an effective execution framework, and examinations to successfully implement such projects. 'Stakeholder communication' with the same weight, is focused on the importance of timely, transparent, and interactive communication among stakeholders. The creation and upkeep of effective communication channels, openness in information sharing, and efficient dispute resolution methods are fundamental for the smooth execution of the project. Both ranked second in importance from an overall perspective in the aquavoltaics policy, emphasizing the central role of effective communication and robust systems in policy implementation. These findings directly support our use of the AHP to address complex policy issues.

Conversely, the low scores for 'short-term impacts of construction' (0.017113) and 'pollution from cleaning solar energy facilities' (0.02248) imply that these factors are considered to have less impact on the implementation of the project. This indicates that, while these factors are recognized, they are not deemed as urgent as those previously mentioned, reflecting a prioritization in the project's broader context.

The results and prioritization of the factor comparison are as illustrated in Table 2.

4.3.3 Sub-factor comparison

In the sub-factor comparison associated with the 'social criterion', 'clear policy planning and guideline' emerges as the most influential, with a weight of 0.122257. This is closely followed by 'interdepartmental coordination' and 'clear distribution of responsibilities and authorities', each with a weight of 0.103448. 'Pre-development communication' is also significant, with a weight of 0.100313, as illustrated in Table 3.

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Table 2: Factor comparison results.

Factor comparison	Global result
Adapting to climate change (environmental)	0.119425
Stakeholder communication (social)	0.093467
Institutional framework (social)	0.093467
Maintaining original ecology (environmental)	0.0843
Aquatic products marketing (economic)	0.08262
Creation of new employment opportunities (economic)	0.068283
Local participation (social)	0.066033
Regulatory authorities (social)	0.066033
Sustainable business models (economic)	0.058077
Site design (development)	0.055107
Site location (development)	0.055107
Restoration measures (environmental)	0.054795
Return on investment (economic)	0.03402
Land consolidation (development)	0.029673
Pollution from cleaning solar energy facilities (environmental)	0.02248
Short-term impacts of construction (development)	0.017113

Table 3: Sub-factor comparison results for the social criterion.

Sub-factor comparison (social)	Result
Clear policy planning and guideline	0.122257053
Interdepartmental coordination	0.103448276
Clear distribution of responsibilities and authorities	0.103448276
Pre-development communication	0.10031348
Standardized examination	0.097178683
Distribution of rights and obligations in private law contracts	0.081504702
Legal reservation	0.07523511
Identification of stakeholders	0.072100313
Open and transparent information disclosure	0.059561129
Dispute resolution	0.059561129
Local influential network	0.056426332
Community-based energy projects	0.034482759
Public attitude	0.034482759

‘Clear policy planning and guideline’ suggests that detailed and comprehensive policy planning is essential, offering clear direction and supportive measures at various stages of the fishery and electricity symbiosis project, thus standing out as the most impactful sub-factor for policy enactment within the social framework. ‘Interdepartmental coordination’ and ‘clear distribution of responsibilities and authorities’ are acknowledged by project stakeholders as critical, highlighting the importance of clarity in agency roles and inter-agency collaboration for the success of the project. Furthermore, ‘pre-development communication’ is the third most significant, underlining stakeholders’ emphasis on early involvement and participation in the project proceedings.

In the sub-factor comparison associated with the ‘development’ criterion, ‘improvement of existing aquaculture operations’ stands out with a weight of 0.153846. This is followed closely by 'electric power transmission' and 'water channel', each with a weight of 0.141026, and then by 'change of traditional aquaculture practices' with a weight of 0.083333, as depicted in Table 4. The significant weight assigned to 'improvement of existing aquaculture operations' reflects stakeholders' expectations that integrating photovoltaics with traditional aquaculture will enhance the existing infrastructure and improve the overall quality of the aquaculture environment. The equal importance placed on 'electric power transmission' and 'water channel' underscores the project's need to balance both photovoltaic-generated electricity and waterways, ensuring that fishery and electricity production can coexist effectively. Lastly, the importance of 'change of traditional aquaculture practices', ranking third within the development criterion, suggests that site design should respect and coordinate with traditional aquaculture practices.

Table 4: Sub-factor comparison results for the development criterion.

Sub-factor comparison (development)	**Result**
Improvement of existing aquaculture operation	0.153846154
Electric power transmission	0.141025641
Water channel	0.141025641
Change of traditional aquaculture practices	0.083333333
Nature-based eco-engineering methods	0.076923077
Land regulations	0.076923077
Issues of justice	0.076923077
Impact on adjacent agricultural crops and aquaculture	0.070512821
Short-term aquaculture disruption	0.057692308
Scale of the project site	0.038461538
landscape and scenery	0.032051282
Impact on nearby communities	0.032051282
Impact on nearby wildlife	0.019230769

5 CONCLUSIONS

Stakeholder perspectives on the aquavoltaics policy are influenced by various factors, which can be divided into two primary categories: 'value choices' and 'issue-oriented selections'. 'Value choices' encompass stakeholder values in various areas, including environmental protection, economic development, and social justice, among others. 'Issue-oriented selections' refer to incidents or disputes that have shaped stakeholders' attitudes toward the policy and influenced their prioritization of different impact factors, including environmental, economic, or social concerns. Due to its complexity, this subject is thus recognized as a 'wicked problem'. The application of the AHP framework assists in deciphering these factors, deepening our understanding of stakeholder preferences, and identifying areas where current systems may be improved. This research endeavours to contribute in the following ways and to establish a data-driven policy decision support framework for aquavoltaics:

- To identify and analyse the main issues and values of public concern, organizing them into factors that may impact the implementation and achievement of policy objectives. By applying the AHP framework, these elements are hierarchically structured and evaluated from the perspectives of various stakeholders. The digitization of community concerns regarding the development of aquavoltaics to date provides evidence-based

recommendations to decision-makers, thereby improving current policies to align more closely with public expectations.
- To integrate the AHP methodology with the existing SFES-ESI, focusing on issues through AHP to create common ground, foster understanding and empathy, and simplify complex decision-making processes. This integration facilitates early identification and resolution of areas of conflict, aiming to establish more efficient communication channels among stakeholders and support the smooth execution of aquavoltaics policy.
- The aquavoltaics policy represents a novel initiative in the development of solar PV in Taiwan. This research may also be taken as an important reference for Taiwan's future development of other renewable energy.

Further research could develop an interactive platform to enhance this study. Such a platform would allow users to directly engage in discussions about issues, thereby deepening their understanding and contributing to relevant topics. By using AI technology to independently analyse each factor and automatically update its importance weights, this approach could potentially increase the efficiency and accuracy of surveys. This would make the decision-making process more transparent and scientific, and better reflect the opinions and positions of the public and all stakeholders.

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REFERENCES

[1] United Nations, *Climate Change Paris Agreement*, 2015.
[2] IPCC, *AR6*, 2022.
[3] BVerfG, Order of the First Senate of 24 March 2021 – 1 BvR 2656/18, paras. 1–270, 2021. https://www.bverfg.de/e/rs20210324_1bvr265618en.html.
[4] Lennon, B., Dunphy, N.P. & Sanvicente, E., Community acceptability and the energy transition: A citizens' perspective. *Energy, Sustainability and Society*, **9**(1), pp. 1–18, 2019.
[5] Bidwell, D., Thinking through participation in renewable energy decisions. *Nature Energy*, **1**(5), pp. 1–4, 2016.
[6] Antunes, C.H. & Henriques, C.O., Multi-objective optimization and multi-criteria analysis models and methods for problems in the energy sector. *Multiple Criteria Decision Analysis: State of the Art Surveys*, eds S. Greco, M. Ehrgott & J.R. Figueira, Springer: New York, pp. 1067–1165, 2016.
[7] Rittel, H.W. & Webber, M.M., Dilemmas in a general theory of planning. *Policy Sciences*, **4**(2), pp. 155–169, 1973.
[8] Warren, C.R., Lumsden, C., O'Dowd, S. & Birnie, R.V., 'Green on green': Public perceptions of wind power in Scotland and Ireland. *Journal of Environmental Planning and Management*, **48**(6), pp. 853–875, 2005.
[9] Voigt, C.C., Straka, T.M. & Fritze, M., Producing wind energy at the cost of biodiversity: A stakeholder view on a green–green dilemma. *Journal of Renewable and Sustainable Energy*, **11**(6), 063303, 2019.
[10] Lee, Y. & Kim, K., Analytical strategies for floating solar PV policy development in South Korea. *Membrane and Water Treatment*, **13**(1), pp. 7–14, 2022.

[11] Sütterlin, B. & Siegrist, M., Public acceptance of renewable energy technologies from an abstract versus concrete perspective and the positive imagery of solar power. *Energy Policy*, **106**, pp. 356–366, 2017.
[12] Sellak, H., Ouhbi, B., Frikh, B. & Palomares, I., Towards next-generation energy planning decision-making: An expert-based framework for intelligent decision support. *Renewable and Sustainable Energy Reviews*, **80**, pp. 1544–1577, 2017.
[13] Hsiung, K.-H., Public participation and legal research in solar PV power plant site selection. *Second International Academic Conference on Public Art and Human Development (ICPAHD 2022)*, **158**, 01001.
[14] Shindler, B.A., Brunson, M. & Stankey, G.H., Social acceptability of forest conditions and management practices: A problem analysis. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, 2002.
[15] Lane, M.B., Regional forest agreements: Resolving resource conflicts or managing resource politics? *Australian Geographical Studies*, **37**(2), pp. 142–153, 1999.
[16] Côté, M.-A. & Bouthillier, L., Assessing the effect of public involvement processes in forest management in Quebec. *Forest Policy and Economics*, **4**(3), pp. 213–225, 2002.
[17] Doljak, D. & Stanojević, G., Evaluation of natural conditions for site selection of ground-mounted photovoltaic power plants in Serbia. *Energy*, **127**, pp. 291–300, 2017.
[18] Ananda, J. & Herath, G., The use of analytic hierarchy process to incorporate stakeholder preferences into regional forest planning. *Forest Policy and Economics*, **5**(1), pp. 13–26, 2003.
[19] Minutolo, M., Application of the analytic hierarchy process for solving social wicked problems: Keynotes and plenary sessions from the 2022 International Symposium of the AHP. *International Journal of the Analytic Hierarchy Process*, **15**(1), 2023. https://doi.org/10.13033/ijahp.v15i1.1156.
[20] Gumus, S., An evaluation of stakeholder perception differences in forest road assessment factors using the analytic hierarchy process (AHP). *Forests*, **8**(5), p. 165, 2017.
[21] Executive Yuan, Promoting green energy innovation, Executive Yuan. https://english.ey.gov.tw/News3/9E5540D592A5FECD/16bd3a41-9c6a-485c-9498-b6b2b8240f6e. Accessed on: 30 Jan. 2024.
[22] Chuang, M.-T., Chang, S.-Y., Hsiao, T.-C., Lu, Y.-R. & Yang, T.-Y., Analyzing major renewable energy sources and power stability in Taiwan by 2030. *Energy Policy*, **125**, pp. 293–306, 2019.
[23] Executive Yuan, Premier applauds green energy successes as first steps towards 2025 goal, Executive Yuan. https://english.ey.gov.tw/Page/61BF20C3E89B856/02099eba-7316-4442-8e17-294ce7d7f2c8. Accessed on: 30 Jan. 2024.
[24] Chen, W.-M., Kim, H. & Yamaguchi, H., Renewable energy in eastern Asia: Renewable energy policy review and comparative SWOT analysis for promoting renewable energy in Japan, South Korea, and Taiwan. *Energy Policy*, **74**, pp. 319–329, 2014.
[25] Liou, H.M., Policies and legislation driving Taiwan's development of renewable energy. *Renewable and Sustainable Energy Reviews*, **14**(7), pp. 1763–1781, 2010.
[26] Hsiao, Y.-J., Chen, J.-L. & Huang, C.-T., What are the challenges and opportunities in implementing Taiwan's aquavoltaics policy? A roadmap for achieving symbiosis between small-scale aquaculture and photovoltaics. *Energy Policy*, **153**, 112264, 2021.

[27] Executive Yuan, Executive Yuan. https://www.google.com/url?client=internal-element-cse&cx=f635b8cf2ce78448c&q=https://www.moeaea.gov.tw/ECW/populace/content/wHandMenuFile.ashx%3Ffile_id%3D7138&sa=U&ved=2ahUKEwi19r3CpvCDAxV0r1YBHWRgC_Y4KBAWegQIAxAB&usg=AOvVaw34gVDp_G0CMdKHyZ9ho4os. Accessed on: 30 Jan. 2024.

[28] Formosa News, Tainan fish farmers say solar power policy is destroying livelihoods and ecosystems. *Formosa News*. https://english.ftvnews.com.tw/news/2023813W02EA. Accessed on: 30 Jan. 2024.

[29] Yuan-Ting, Y., Hsin-Fang, L. & Chin, J., Tainan residents rally against new solar projects in Cigu. *Taipei Times*. https://www.taipeitimes.com/News/taiwan/archives/2022/11/04/2003788255. Accessed on: 30 Jan. 2024.

[30] Wang, H.-W., Dodd, A. & Ko, Y., Resolving the conflict of greens: A GIS-based and participatory least-conflict siting framework for solar energy development in southwest Taiwan. *Renewable Energy*, **197**, pp. 879–892, 2022.

[31] Saaty, R.W., The analytic hierarchy process: What it is and how it is used. *Mathematical Modelling*, **9**(3–5), pp. 161–176, 1987.

[32] SurveyCake, SurveyCake. https://www.surveycake.com/s/BZYDa. Accessed on: 2 May 2024.

[33] AHP-OS, AHP Online System – AHP-OS. https://bpmsg.com/ahp/. Accessed on: 2 May 2024.