Journal of the Asian Academy of Applied Business
Vol. 10 (December 2025), 115-135
ISSN 1675-9869

STRATEGIC ANALYSIS OF ENERGY ISSUE: A COMPREHENSIVE SWOT/TOWS-AHP APPROCH

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Received date: 21 July 2025 | Revised date: 15 August 2025 | Accepted date: 03 September 2025

ABSTRACT

This research performs a thorough strategic examination of the energy sector in Sabah utilizing an integrated SWOT/TOWS-AHP methodology. Sabah's energy system is lagging behind national standards because of inadequate infrastructure, geographical remoteness, and a lack of skilled workers. Nevertheless, the state has considerable untapped potential in renewable energy resources, and recent developments, such as the establishment of the Energy Commission of Sabah (ECoS), signals progress. Such as A hybrid system with PV/WT/Battery/DG is the most competitive in providing low-cost electricity to remote communities in Malaysia's Sabah state (See et al., 2022). The study employs SWOT analysis to assess internal strengths and weaknesses, and external opportunities, threats, and utilizes the TOWS matrix to formulate actionable strategies. These strategies are then ranked with the Analytic Hierarchy Process (AHP), which measures and compares the relative value of each strategic option. The findings demonstrate that initiatives such as Sabah leveraging climate finance and green investment have high potential, while regulatory and technological innovation is also key. This study provides strategic guidance for infrastructure modernization and investment facilitation, and institutional strengthening and climate resilience enhancement. This combined effort provides clear guidance on how to shift the system Rational Integrated Approach to Climate and Energy Policy in the SCs of East Malaysia with the aim of enabling Sabah to exemplify green state development.

Keywords: Energy Sector Development, SWOT/TOWS Analysis, Analytic Hierarchy Process (AHP), Renewable Energy, Sabah Energy Transition

1.0 Introduction

The energy sector in Sabah is crucial for the socio-economic development of the state, but at the same time, it faces technological setbacks. Sabah's energy infrastructure has suffered from outdated transmission systems, an over-reliance on diesel generators in rural areas, and technical faults alongside weather-related disruptions over the past decades. These stubborn weaknesses have perpetuated the lack of accomplishing energy access and has increased the operational costs while decreased service trustworthiness in comparison to Peninsular Malaysia. Besides, lower-segment penetrating Sabah's rugged mountains and scattered rural settlements pose geographical hindrances to grid extension, worsening the state's energy inequality.

Understanding the need for policy adjustment, the Sabah progressively set up Energy Commission of Sabah (ECoS) in January 2023. Under the ECoS Act of 2024, ECoS is empowered to commercially regulate electricity supply, onshore gas, and renewables. This

attempts to further define the scope of decentralization and allow more refined socio-political control by the federal government over Sabah's energy policy formulation and execution. Control over the commission permits the state to focus on improved adoption of renewables and modernization of energy infrastructure to better management service disruptions. While there has been some progress with ECoS as a policy framework, lacking adaptive capacity as well as environmental, governance, and unskilled labor shortages are major obstacles toward sustainable energy developmental solutions.

Globally, energy transitions are progressing at an accelerated pace due to innovation of technology, shifts in climate imperatives, as well as consumer preferences. Because of its vast renewable resources like hydro, solar, and biomass, Sabah is strategically positioned to take advantage of these changes (International Renewable Energy Agency, 2022). Other Climate Finance frameworks and sustainable development partnerships also offer innovative opportunities for Sabah to transform with modern advanced technologies. However, these opportunities come with internal vulnerabilities and external threats that need to be tackled. Some of the most critical issues include the climate change impacts on the energy infrastructure, political instability which may offer inconsistent governance, and the lack of skilled workers to undertake complicated renewable energy projects (International Energy Agency, 2023).

Considering these interrelated realities, Sabah's energy future requires a strategic plan based on concrete evidence. This study makes use of SWOT/TOWS analysis to assess the internal and external factors that impact the energy sector in Sabah. Also, AHP (Analytic Hierarchy Process) is incorporated to rank the strategic parameters in a more logical order, thus providing a measurable basis to the decisions that need to be made. The aim of the paper is to determine actionable recommendations through the integrated approaches to enable the State of Sabah to align its strengths and opportunities while reducing its vulnerabilities to optimally transition towards a more secure, sustainable, and inclusive energy system.

2.0 Methodology: SWOT/TOWS and AHP Application

2.1 Methodology and Application

A research methodology describes the methods and procedures used to identify and examine information related to a specific research topic (Lada et al., 2024; Sreekumar, 2023). This research applies strategic tools such as SWOT analysis and Analytic Hierarchy Process (AHP) to identify and rank important factors that affect the e-commerce preferences among university students.

2.2 SWOT Analysis

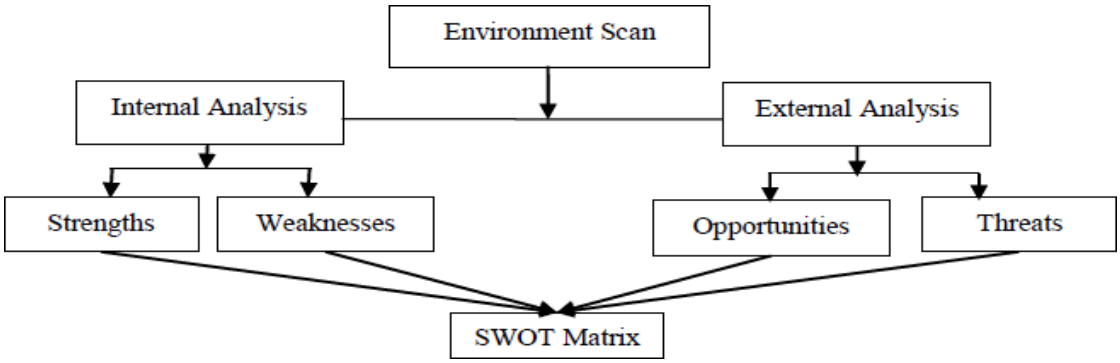

Figure 1: Framework of SWOT Analysis

SWOT analysis is a strategic planning tool used to analyse internal and external factors in order to acquire a systematic approach and support for a decision situation (Kenton, 2024). The internal and external factors are most considerable for the industry or organization's future and are referred to as strategic factors. In SWOT, these factors are grouped into four parts known as SWOT groups which include strengths, weaknesses, opportunities and threats as shown in figure 1.

Strengths and weaknesses are internal factors. They are characteristics of a business firm that offer relative advantages or disadvantages over its competition. Strengths may be any number of areas or characteristics where a business excels and has a competitive advantage over its competitors while weaknesses are the aspect or characteristics where a business is at a competitive disadvantage relative to its competitor. On the other hand, opportunities and threats are the external factors. Opportunities are elements of the external environment that are able to improve business performance growth. However, threats are elements of the external environment that could cause trouble for the business firm (Peterdy, 2024).

2.3 Analytic Hierarchy Process (AHP)

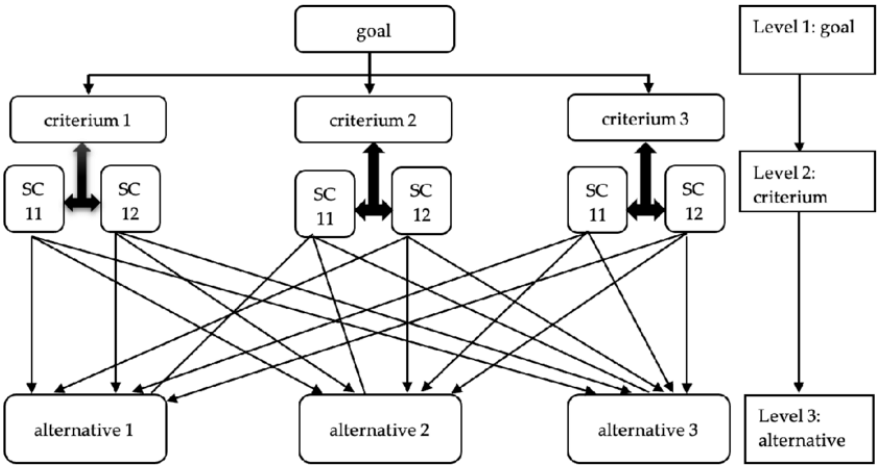

Figure 2: Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) developed by Thomas L Saaty in the 1970s (Taherdoost, 2017). It is a multi-criteria decision-making approach that breaks down the decision problem into a hierarchical structure consisting of goals, factors, sub factors and alternatives. AHP is based on three key principles. First is the structure of the model, second is the comparative evaluation of the criteria or alternatives and third is the synthesis of the priorities. In the literature, AHP has been widely applied to address various decision-making problems. The AHP organizes objectives, decision criteria and alternatives into hierarchical structure similar to a family tree. This hierarchy typically consists of at least three levels including the overall goal of the problem at top, multiple criteria defining the alternatives in the middle and the alternatives at the bottom level.

In this research, the AHP method is used to prioritize SWOT elements. After following the decomposition of the problem and construction of the hierarchy, the prioritization process begins by determining the relative importance of the criteria. In each of the levels, criteria are compared in pairs against each other with respect to their

influence and in relation to the criteria at the higher level. The AHP employs a standardized comparison scale of nine levels to conduct the pairwise assessment. The AHP approach in decision-making involves four stages as mentioned below.

Stage 1: define the problem and set up the structure of the hierarchy.
The initial first level involves defining all decision components of the problem. The first top level is broad general objective. The lower levels contain the sub- objectives and attributes that influence the decision itself. The various possible alternatives exist at bottom level.

Stage 2: collection of input data.
Input data implies to the impact of each element on each sub-objective in the adjacent upper level of hierarchy. The information is placed in a matrix for pair-wise comparisons. For example, if we have seven elements on level L and two elements on level L-1, we have 7 x 7 matrix for each of the two elements on level L-1. The matrix is called as reciprocal judgement matrix. To fill this matrix, we need to make 10L (L*(L- 1)/2 5 7*6/2) comparisons. The diagonal cells of this matrix are filled with 1 and rest of the matrix is filled with reciprocal values. AHP uses a 1–9 scale of measurement in pair-wise comparisons. Nine implies to highly preferred element over the other element to which it is compared. One implies to an equally important element. In between values are signifying various degrees of relationship.

Stage 3: find the relative weights with the eigenvalue method
The relative priorities of different criteria (sub-criteria) are not easily plausible from the judgement matrix. In this stage, relative weights of a set of objects (criteria, sub-criteria and alternatives) are calculated with the matrix of pair-wise comparison B=bij which is positive and reciprocal (1–9, and 1–1/9).

Thus, the given matrix B such that

$$B = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ b_{n1} & \cdots & \cdots & b_{nm} \end{bmatrix}$$

where $B_{ij} = 1/B_{ji}$ for all I, j = 1, 2, 3..., n

Compute a vector of relative priorities w = (w1, w2... w3). The w is normalized so that it adds up to 1 or 100. If all the judgements are consistent, then

$$*b_{kj} = b_{ij} \text{ for all I, j = 1, 2 } \cdots, \text{ n}$$

Then, normalizing any column j of matrix B will generate the wts b_{ik}

$$W_i = \frac{b_{ij}}{\sum_{K=1} b_{kj}} \text{ for all I, j = 1, 2K } \cdots, \text{ n}$$

Pair-wise judgement is often error-prone and condition in the second equation may not be confirmed. Consequently, the final result of priorities may depend upon the column chosen for normalization. Such a problem can be solved either by logarithmic least square (LLS) or eigenvector method developed by Saaty. Latter is a simpler procedure than former and also involves averaging all possible ways of comparing alternatives (Harker & Vargas, 1987). Calculations of the wt. vector as the right eigenvector of the matrix B:

$$Bw = \lambda max\ W$$

where λ max is the maximum eigenvalue of matrix B. So the weight vector can be enumerated as

$$Wi = \frac{\sum_{J-1}^{N} bij*wj}{\lambda_{max}}$$

Inconsistencies in judgement can be calculated by eigenvector method. Satty research depicts for λ max n for positive reciprocal matrix. For a perfectly consistent matrix then λ

max = n. Satty defined a consistency index by the formula

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Also, consistency ratio (CR) is measured as ratio of CI and random index (RI)

$$CR = CI/RI$$

Therein RI the random index is computed as the mean of CI of randomly generated matrices of size n.
If CR < 0.1, it is acceptable, and if CR > 1, the DM has to re-evaluate the decisions in order to reduce inconsistencies.

Stage 4: develop a composite priority vector for bottom most level of the hierarchy to rate alternative decision strategies

The aim of employing AHP is to rank or prioritize different decision alternatives depending on how well each one meets the objective or goal. The final aggregate ranking for the decision alternatives is done by adding up all the weighted eigen entries corresponding to all levels (right down to the alternatives). Eigenvectors are weighted according to weight of the criteria.

2.4 SWOT-AHP Hybrid Methodology

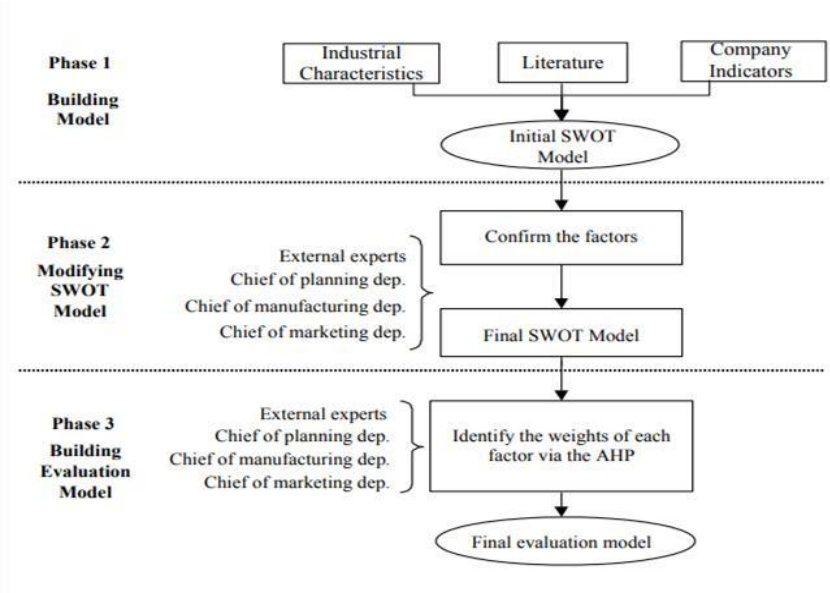

Figure 3: Phases of Proposed Methodology

Figure 3 show a SWOT-AHP based strategic management model. In order to create a SWOT-AHP based strategic management model, three phases model needed which is building initial task, modifying factors, and building an evaluation model. SWOT factors are subjected to pairwise comparisons concerning higher level factors, in order to generate the priority factors using eigenvalue calculations. Although SWOT analysis lacks the quantitative feature needed to generate ranking mechanism for identified factors, the integration of the Analytic Hierarchy Process (AHP) addresses this limitation. The hybrid model of SWOT-AHP systematically qualifies the relative importances of SWOT factors and evaluates their intensity, thereby providing a robust framework for strategic decision-making.

Application of AHP in the SWOT framework is supposed to quantify and evaluate the importance of the SWOT factors systematically. Three major steps are followed in this regard. First and foremost is the identification of the internal and external key factors such as strengths, weaknesses, opportunities and threats. Next is applies the pairwise comparisons to capture the weights of each SWOT group. Finally uses the AHP to derive the relative priorities of each factor within the SWOT groups. The overall weight and ranking of each factor are obtained by multiplying its local weight by the weight of its respective group, resulting in a comprehensive prioritization framework.

Table 1: Pairwise Comparison Scale

ert opinion on pair-wise ranking of importance of two sub-criteria with reference to the main criteria in tree hierarchy	
tion A and option are equally important	1
tion A is moderately more important than option B	3
tion A is strongly more important than option B	5
tion A is very strongly more important than option B	7
tion A is extremely more important than option B	9
tion A and option B are equally important	1

Table 1 provides a clear representation of the AHP scale which often used for pairwise comparisons in decision-making. In decision-making frameworks such as AHP, a pairwise comparison scale is needed to quantify the relative importance of two criteria or sub-criteria with respect to a higher-level goal or main criterion. After identifying all the key factors for each SWOT category, they are subjected to pairwise comparisons to evaluate their relative importance within each group. For instance, comparing one strength to another strength. Furthermore, higher-level comparisons are conducted to determine the weight of each SWOT category relative to others. For example, the importance of strengths versus threats. Eigenvalue calculations are used to generates quantitative weights for all the SWOT factors and ranking them based on their strategic significance. The pairwise comparison scale is based on a set of values ranging from 1 to 9. This scale ensures consistency and allows decision-makers to mathematically evaluate subjective judgements which are then processed to calculate weights for the key factors of SWOT categories. Furthermore, these weights provide a quantitative foundation for prioritization in strategic analysis.

3.0 Strategic Environmental Analysis: SWOT Outcomes

Developing appropriate strategies for Sabah's energy sector requires an understanding of the region's internal dynamics and external conditions. SWOT analysis offers strategic insight into the most critical issues underlying Sabah's energy development. For the purposes of this analysis, internal factors are classified as strengths and weaknesses which are relative to the state's control, while external factors as opportunities and threats which result from higher order systems and environmental contexts.

Strengths

There are several important internal attributes that put Sabah in a strategic position for energy reform. Firstly, the available renewable energy resources are a notable strength. The state has vast potential for hydropower in the interior highlands, ample solar radiation suitable for PV generation, and biomass sources from its large agricultural sector (International Renewable

Energy Agency, 2022). These resources give a competitive edge and put Sabah within favorable consideration for shifting to clean energy.

Secondly, the initial operational activities undertaken by ECoS, which is the Energy Commission of Sabah, mark out important institutional developments. As ECoS comes under supervision of Energy Commission of Malaysia, with jurisdiction on the supply of electricity, distribution of gas, and renewable energy, there is a degree of control which denotes progress in local self-governance (Energy Commission of Sabah, 2024a). This development enables the region to design and implement energy policies aligned to its geographic socio-economic realities, improving agility of response and integration.

Weaknesses

As highlighted previously, the structural issues within Sabah's energy region poses the most hindering problems. One core problem is the fragmentation and aging of the electrici ty infrastructure. The majority of the transmission and distribution network was built decades ago and lacks the capacity to meet rising demand as well as incorporate variable renewable energy sources. Moreover, the instability of the grid along with common voltage fluctuations particularly in rural and remote areas engenders frequent power outages, further drives down investors' confidence (The Star, 2024).

Perhaps one of the more paramount concerns would be the lack of skilled human capital. As previously stated, workforce participation in technical roles in Sabah, particularly design and integration of renewable energy projects, as well as compliance to regulations, is very minimal. This skill deficiency hampers implementation timelines and increases reliance on external consultants which, in turn, hinders development of local knowledge.

Opportunities

Sabah can directly take advantage of a few emerging external opportunities. The global push for clean energy has resulted in heightened international funding alongside technology transfer programs aimed at aiding energy transition in developing areas (International Energy Agency, 2023). Institutions like the Asian Development Bank and Green Climate Fund provide funding for renewable infrastructure along with initiatives aimed at improving access to energy.

The existing geographical challenges of Sabah could be addressed with the help of latest technology in microgrids, battery storage, and smart meters that fall under decentralized energy systems." These technologies ensure reliable power to remote communities without expensive grid extensions.

Threats

Derailed progress is also a concern for Sabah. One of the most concerning risks includes climate change, especially in the form of extreme weather like flooding or landslides that can damage energy infrastructure and disrupt the supply chain. In addition, political instability at both state and federal levels endangers the commitment to energy policy frameworks, which is essential to stabilize after long-term investments, due to shaky governance in the region. In the short-term, political instability increases clean energy consumption, but in the long run, it diminishes clean energy use and long-term environmental quality (Sohail et al., 2021).

To conclude, the SWOT analysis shows that there is abundant strategic potential in the energy domain of Sabah, but operational, environmental, and institutional challenges need to be approached first. Systematic evaluation of these challenges will enable achieving energy security and state sustainability.

strengths	**Weaknesses**
S1. Abundant Renewable Resources (Ullah et al., 2024) S2. Regulatory Autonomy via ECoS (Burri & Kugler, 2024) S3. Alignment with Global Sustainability Goals (Buerkle et al., 2023). S4. Increasing Support from Stakeholders (Henisz et al., 2013).	W1. Outdated Electricity Infrastructure (Rivera et al., 2023) W2. Geographic Disparities in Electrification (Hosen et al., 2024) W3. Shortage of Skilled Technical Personnel (Hassan & Riaz, 2024) W4. Inflexible Energy Storage Systems and Grid Modularity (Tong et al., 2025)
Opportunities	**Threats**
O1. Access to Climate Finance Resources (Pauw et al., 2022). O2. Innovative Technology (Green et al,2019) O3. Heightened Interest in Environmentally Responsible Investments (Chițimiea et al., 2021). O4. Potential for Leadership in/at a Regional Level (Samarkina et al., 2023)	T1. Negative Impact of Climate Change (Kabir et al., 2023). T2. Unreliable Government Policies Over Investment Risk (Zhang & Gu, 2024). T3. Vulnerable Supply Chains (Sharma et al., 2021) T4. High Costs of Capital (Drobetz et al., 2017)

As noted from the earlier SWOT-AHP analysis, there is a clear ranking order concerning underlying strategic factors in relation to Sabah's energy transition. Out of the strengths, the most important is S1: Abundant Renewable Resources, which through abundance of value and 'weight' (26.1%) serves in the top SO1 strategy rank tier (which is Sabah's solar, hydro and biomass potential). Sabah not only has a competitive edge but also attracts international climate finance. Following closely is S3 Alignment with Global Sustainability Goals (14.3%) which highlights ESG investors and respondents towards Sabah and also underlined synergies with global energy transitions. S2 Regulatory Autonomy via ECoS is third (11.7%), which indicates the relevance of Sabah's governance structures on the implementation and oversight of energy policies within the region. S4 Increasing Support from Stakeholders also fares relatively well at (8.0%), signaling positive change of support towards local and international sides for energy reforms.

In terms of weaknesses, W1: Outdated Electricity Infrastructure (close to 6.9%) represents the most significant internal barrier limiting capacity and reliability towards energy reform. W2: Geographic Disparities in Electrification follows, interlinked with access barriers to the dense rural hinterlands, particularly mitigated using modular microgrid solutions. However, W3: Shortage of Skilled Technical Personnel and W4: Inflexible Energy Storage Systems and Grid Modularity are deemed less important (1.1% and 1.0%, respectively). This explains how although crucial in the long run, these aspects are not viewed as strategically transformational accelerators.

With opportunities, although exact percentages are not isolated in the AHP output, O1: Access to Climate Finance Resources and O3: Heightened Interest in ESG Investment clearly assume high strategic relevance. These support the most prioritized strategies (SO1 and SO4) and testify to Sabah's strong position to attract global support. O2: Innovative Technology is moderated, allowing Sabah to bypass traditional infrastructure restrictions through implementing microgrids and smart energy technologies. O4: Potential for Regional Leadership also bears strategic significance, strengthening Sabah's aspirations to become a clean energy leader in Southeast Asia.

T2: Unreliable Government Policies and T1: Negative Impact of Climate Change are ranked the highest in threats with scores of approximately 8.0% and 7.5%, respectively. These are outside factors which can set back energy growth unless countered by dependable bodies like ECoS. T4: High Costs of Capital and T3: Vulnerable Supply Chains have lower rankings, but remain relevant, indicating a need for planning that takes risks into consideration, including supply chain diversification.

In essence, the evaluation captured that the most strategically critical for Sabah is focus on opportunity and strength, particularly those involving external financing and renewable resources. Underlining weaknesses and threats, while significant, tend to be relatively less salient, serving more as primary and supportive elements to resilience instead of driving transformational change. This provides rationale for growing fokusing on leveraging Sabah's strengths and external opportunities.

SWOT	Code	Description	Relative weight (%)	Prioriti Rank
Strength	S1	Abundant renewable resources	26.15	1
	S3	Alignment with global sustainabiluity goals	14.3%	2
	S2	Regulatory autonomy via ECoS	11.7%	3
	S4	Increase support from stakeholders	8.0%	4
Weakness	W1	Outdated electricity infrastructure	6.9%	5
Threat	T1	Negative impact of climate change	7.5%	6
Threat	T2	Unreliable government policies	8.0%	7
Weakness	W2	Geographic disparities in electrification	4.0%	8
Threat	T4	High cost of capital	5.1%	9
Threat	T3	Vulnerable supply chains	4.4%	10
Weakness	W4	Inflexible energy storage systems and grid modularity	1.0%	11
Weakness	W3	Shortage of skilled technical personnel	1.1%	12
Opportunity	O1	Access to climate finance resources	High influence	High (1-2)
			on SO1,WO1	
	O2	Innovative technology	Medium (via SO3, WO3)	Mid-high (1-2)
	O3	Heightened interest in ESG investment	High (SO1,SO4)	High (1-2)
	O4	Potential for regional leadership	Medium (SO2, WO4)	Mid

4.0 Tows Matrix for Sabah's Energy

Using the TOWS matrix and prioritization through SWOT-AHP analysis, this subsection formulates strategic recommendations that will help achieve the energy transition goal for Sabah. These recommendations aim to holistically combine Greater Sabhas internal capabilities and the ever-changing global landscape, while also dealing with the state's threats, structural constraints, and weaknesses. They fall under four overarching strategic pillars which are: modernizing infrastructure, facilitating investments in renewable energy, developing institutional and human resource capacity, and climate change governance for resilience.

	Opportunities O1. Access to Climate Finance Resources O2. Innovative Technology O3. Heightened Interest in Environmentally Responsible Investments O4. Potential for Leadership in/at a Regional Level	**Threats** T1. Negative Impact of Climate Change T2. Unreliable Government Policies Over Investment Risk T3. Vulnerable Supply Chains T4. High Costs of Capital
Strengths S1. Abundant Renewable Resources S2. Regulatory Autonomy via ECoS S3. Alignment with Global Sustainability Goals S4. Increasing Support from Stakeholders	SO1: Create opportunities of strategic concern by formulating climate finance projects that utilize Sabah's natural resources and constructed renewable energy projects of financing appeal. (S1, O1, O3) SO2: Market and position Sabah for green investors as a sustainable energy hub for the region in need for broader regional influence (S3, O4). SO3: Utilize ECoS to expedite the endorsement process for the pilot applications of innovative	ST1: Implement ECoS regulatory control for enforcement of climate-resilient energy infrastructure standards (S2, T1). ST2: Utilize global alignment of stakeholders to create advocacy efforts for bipartisan long-term energy policies (S3, S4, T2). ST3: Establish local partnerships to develop component supply chains to mitigate dependence on international markets (S1, T3). ST4: Focus on…bundled renewables with low modular serial
	technologies in solar and microgrid systems (S2, O2). SO4: Lead hybrid campaigns to awaken shareholder ESG investments and promote active stakeholder momentum that aligns with corporate growing momentum (S4, O3).	dependencies such as solar + storage to reduce capital risk (S1, T4).

Weaknesses W1. Outdated Electricity Infrastructure W2. Geographic Disparities in Electrification W3. Shortage of Skilled Technical Personnel W4. Inflexible Energy Storage Systems and Grid Modularity	WO1: Utilize international grants and financing to achieve the goals of modernized grids and expanded rural access within the region (W1, W2, O1). WO2: Collaborate with foreign energy companies and universities to develop tailored training programs to increase local technical capacity (W3, O2). WO3: Deploy adaptable technology-based modular microgrid systems designed specifically for remote regions of Sabah (W2, W4, O2). WO4: Shift global perception and attract international partners by leading in recognition with advanced renewable resource R&D montages for global collaboration (W3, O4).	WT1: Supply chains must incorporate redundancy and tech sourcing diversity to mitigate procurement risks. (W4, T3) WT2: Employ regulatory tools to shield long-term investments from abrupt and politically motivated alterations. (W1, T2) WT3: A centralized digital monitoring system for remote grids will cut operating and maintenance costs, and enhance reliability. (W1, W2, T4) WT4: Enhance skill localization to limit exposure to international labor markets. (W3, T3)

Facilitate and accelerate investment in renewable energy projects

It is recommended that the state immediately initiate the planning and implementation of fully developed, bankable solar and small hydropower projects. With the new regulatory freedom under ECoS, the state has untapped solar energy potential, which should be sponsored through the establishment of a Renewable Energy Investment Facilitation Office (REIFO) dedicated to managing investor relations, streamlining application workflows, and incentive distribution. This newly created body should act as a clean energy project developer concierge, managing outreach and providing a consolidated portal to domestic and global stakeholders. Funding gaps caused by project delays in line with international ESG focused investments, such as those from the Green Climate Fund and Asian Development Bank, will be easily bridged by the State's strategic investment position (International Energy Agency, 2023).

Make new developments to the infrastructure with technologies that are ready for the grid

For strategic improvement in grid strength and flexibility, Sabah needs to adopt smart technologies, which include energy management systems, advanced metering infrastructure, and grid automation as well as energy storage systems integration. In addition to their loss reduction functions, these new technologies will also increase the system's ability to cope with intermittent renewables. More attention should be focused on remote and underserved communities by developing modular microgrids that provide electricity without expensive transmission lines of providing transmission lines. Capital cost mitigation initiatives should be enhanced by international donor support and blended finance models.

Develop the human capital and institutional capability

There is a gap in skilled manpower with technical competencies for the energy value chain. To bridge the gap, Sabah needs to sponsor local training and empowering initiatives with partnerships with clean energy undertakings from abroad, universities, and vocational training institutions. ECoS can lead the development of a Competency Accreditation Framework Modeling focusing on Renewable Energy Systems Design, Installation, and Regulation. This will enable the state to reduce dependence on external expertise, shorten project lead times, and offer green employment opportunities.

Climate resilience and policy stability institutionalization

Facing the dual threats of political instability and climate change, Sabah must place institutionalized frameworks of energy policy within strategic planning horizons in ECoS. This includes multilateral policy frameworks at the regional level as well as climate-resilient infrastructure standards enforced through ECoS. Constructing robust public communication strategies of primary communication tools surrounding energy reforms can build stakeholder trust and safeguard projects from political sabotage. Moreover, policy attribution chains such as technology diversification and adaptation policy contract flexibility will further enhance project resilience to uncertainty.

Advocating policies in these ways will not only resolve immediately pressing energy concerns facing Sabah, but also strategically advance the province as an anticipatory pioneer within the region's clean energy paradigm shift. Achieving these objectives will necessitate meeting operational and transitional efficiency towards sustainably, equitably, and enduringly militarily always on standby and energy secure.

Strategy highlights:
SO1–SO4: Offensive, growth-oriented strategies leveraging strengths to capitalize on investment and innovation trends.

ST1–ST4: Defensive but proactive strategies using internal strengths to counteract vulnerabilities like climate change and supply chains.

WO1–WO4: Improvement strategies that convert weaknesses into capabilities through smart use of external support.

WT1–WT4: Risk-avoidance strategies focused on minimizing exposure through resilience, redundancy, and internal reform.

5.0 Conclusion

This case study makes use of an integrated approach of SWOT/TOWS-AHP to streamline the frameworks in strategic planning for energy development with a focus on the salient factors in need of prioritization. It also examines the unique geographical context of Sabah within the ARDA framework which allows for an effective comparison between state and private sector actors to evaluate investment opportunities. Hot works captured the variable Sabah features, managed under ECoS it offers enhanced regulatory flexibility along with richly abundant renewable resources keeling the scepters of regulation under control with eco autonomy. Still,

eco benevolent offer human capital exert systemic inflexibilities weakening regulatory metrics. Eco financed and climate angered the region is bound to technological shifts unparalleled even by political uncertainties.

Challenging and shaping this region is placed under threat by advanced financial as well as strategic climate governance. Engineering systems able to sustain political boundaries and climate enabled incitement provided the backbone while investing into renewable sources geared with a smart contemporary governance grid climate enables eco posture and solidifies the system intermingling. Borrowing from advanced system resilience whilst claiming embraced autonomy becomes key throughout. Able to keep commitments while being politically restrained enables proper multilateral alignment with even general sustained policy shifting towards commitment. Effective execution marked with ideal aligned containing financial incentive offers benefit for reliable enhanced access to energy and propelling ASEAN highlighted mentored sustainable system development region wide setting Sayab as the sticking point for introspection guided by strategic energy planning. Keeping mentored region under focus requires sustained policy input mentored strategic outputs presented to head planners with de facto logiting enhanced credibility.

6.0 Analytic Hierarchy Process (AHP) Results and Interpretation

Sabah's green investment and sustainable development approach over a five-year period is marked with a more nuanced and systematic prioritization of strategic objectives (SO), strategic tactics (ST), weaknesses/opportunities (WO) and weaknesses/threats (WT). The analysis showcases a deliberate and phased approach that prioritizes foundational development, positioning, and institutional strengthening, which are essential prerequisites for enduring environmental and economic wholistic strength.

Porter's competitive frameworks as well as the Grant's theory aligns perfectly with redeemer SO1: Create opportunities of strategic concern, which singlehandedly garners the most attention at 20.8% weight. Strikingly, this underlines the investment enabling environment sufficiency and opportunity centricity. Subsequent focus on opportunity accentuated with clear infrastructure system enables long term sustainable investment anchored by strong governance and ecosystem is another marked characteristic (Porter, 1998; Grant, 2016).
SO2: Market and position Sabah for green investment (19.2%) gets the next priority, demonstrating renewed drive towards advertising the state as a new player in sustainable energy. Shift towards rebranding and marketing garners both foreign and local attention to green capital, and is supported by OECD (2011) policies on clear vision and signal-marked investment attraction through catalysed policymaking and assured strategic blanketing.SO3, which revolves around the endorsement procedure's acceleration with the use of the Environmental Compliance System (ECoS) at 15.3% while SO4 dealt with hybrid awareness raising campaigns for stakeholders at 10.5%, capture the gaps on the green development innovation sociotechnical system changes on green development at behavioural and institutional levels. The application of digital systems such as ECoS indicates the extent of Sabah's progress towards intelligent governance. This is in tandem with UNEP's (2021) call for environmental information systems and systems thinking for decision making. Hybrid stakeholder engagement campaigns support participatory governance which has been shown to encourage collective ownership of energy transitions (IEA, 2020).

Strategy code	Strategy description	Priority weight (%)	Rank	Strategic Interpretation
SO1	Create opportunities of strategic concern	20.8%	1	This approach focuses on the potential of Sabah to harness its renewable resources (such as hydro, solar, and biomass) for its energy development. It aids in the development of green energy projects eligible for international climate financing. Such self-governance and policy control considered alongside clean energy investment makes Sabah strategically positioned for global investment sustenance and growth for the future (World Bank, 2020; UNEP, 2021).
SO2	Market and position sabah for green investment, attracted	19.2%	2	Although Sabah has remarkable possibilities in green energy, it has yet to capture the attention of investors. This strategy attempts to address the issues of marketing, branding, and advertisement on foreign markets to enhance its competitiveness. Winning regions in green economy tend to formulate strong
				narratives and engage in international climate discussions~/forums (OECD, 2011; ADB, 2022).
SO3	Utilize ECoS to expedite the endorsement of innovative technologies	15.3%	3	In this strategy, ECoS (Energy Commission of Sabah) utilizes its power to expedite the approval of novel, clean technologies. It demonstrates how proactive order supports invention in green energy. Appropriate regulatory policies are effective in minimizing lags and fostering private sector engagement (IRENA, 2019; IEA, 2020).
SO4	Lead hybrid Campaingns to awaken shareholder	10.5%	4	This strategy combines digital and analogue approaches to engage both public and private stakeholders. Its aim is to advance support, build awareness, and catalyze investment from stakeholders. Hybrid communication campaigns are reported to improve partnerships and increase the likelihood of project success (UNEP, 2021; KPMG, 2019).

Strategic Tactics (ST): Regulation and Localization

Among these, ST1: Implement ECoS regulatory control (7.6%) stands out. This responds to Sabah's need to further strengthen the compliance mechanisms and environmental governance, especially with regard to energy pertaining projects. Adequate regulation is integral in fostering confidence in investors and projects, as underlined by IRENA (2019). While examining ST4: Focus on bundled renewables (4.8%) and ST3: Establish local

partnerships (4.2%), it is evident that the two combined show the province's effort towards diversifying its energy mix and fostering community collaboration. These middle level strategies illustrate the need for modular and small scale implementation and reinforce the arguments made by the Asian Development Bank (ADB 2022) on the regional energy success being highly reliant on bottom-up strategies working in conjunction with top-down systems. Southeast Aisa has faced the challenge of alignment with global frameworks. ST2: Utilize global alignment of stakeholders, which appears to place lower priority on international engagement effort at 3.9%, displays greater strategic difficulty, diminishing value assigned to coordination on a global scale. This is emblematic of struggles across Southeast Asia whose alignment with frameworks at a global level tends to lag for bureaucratic and infrastructural reasons (World Bank 2020).

Strategy code	Strategy description	Priority weight (%)	Rank	Strategic Interpretation
ST1	Implement ECos regulatory control for enforcement	7.6%	5	This approach stresses the importance of the Energy Commission of Sabah (ECoS) in managing green energy projects through the enforcement of comprehensive regulations. With ECoS exercising its regulatory powers, compliance, transparency, and safeguard measures to fend off expropriation risks are ensured. Having sufficient enforcement mechanisms encourages investment as well as
				helps to manage investment risks in more advanced renewable markets (IRENA, 2019; IEA, 2020).
ST2	Utilze global alignment of stakeholders	3.9%	8	This approach seeks to integrate the energy development of Sabah with international targets and standards like the Paris Agreement and the Sustainable Development Goals (SDGs). Partnerships with international institutions form global strategic networks which improve credibility alongside alternative funding sources and facilitate inter-country collaboration (UNEP, 2021; ADB, 2022). Despite placing lower in priority, it strengthens strategic resilience through international collaborations.
ST3	Establish local partnerships to develop supply chain	4.2%	7	This approaches seeks to form alliances with local industries for the purpose of creating a regional supply chain for green technology. Increasing local production and decreasing dependence on imports will improve supply chain security and reduce vulnerability to external shocks. Strengthening domestic capabilities is vital to the construction of green jobs and sustainability (World Bank, 2020; KPMG, 2019).

ST4	Focus on low-capital-risk bundled renewable system	4.8%	6	This approach incorporates the integration of solar energy with storage systems which mitigates capital risks. Such bundled systems are easier to implement, especially in rural and remote regions, and are economically more beneficial. These systems are flexible and scalable which makes them perfect for incremental deployment of green energy initiatives (IRENA, 2019; IEA, 2020). This approach is particularly important for reducing the costs and barriers to entry.

Opportunities and Threats: Long-Term Mitigation

WO and WT categories are markedly under filled compared to their counterparts, with the broad set of overseas collaborations topping the list. In the case of WO2: Collaborate with foreign energy companies, an abnormally low 3.3% becomes a notable flag. It becomes even more surprising when exploring the context of their partnerships for capital, technology, and expertise. Their lack of priority signals a shift focus on internal strengthening of the ecosystem. The same applies to WT1: Incorporate supply chain redundancy (1.9%) and WT4: Enhance skill localization (1.0%) which embody a forward-thinking stance to mitigate risk, albeit gradually. KPMG (2019) recommends these strategies, advocating the need to mitigate infrastructural risks while emphasizing the need for skill development, in addition to other leadership centered frameworks that advocate proactive foresight.

In a competitive green investment hub, Sabah aims to position itself at the forefront with a clear focus on foundational growth, regulatory refinement, and marketing vis-a-vis the brand as seen in the five year strategic priorities. Foundations in opportunity creation and aggressive marketing indicate a readiness stage whereas supporting activity tactics highlight early construction towards a long-term sustainability plan. Sabah's strategies currently appear to be more focused on local capabilities, international alignment, and reactive mitigation but broadening emphasis on redirects even slightly towards those aspects would alleviate friction and accelerate the transition.

Strategy code	Strategy description	Priority weight (%)	Rank	Strategic Interpretation
WO1	Utilize international grants and financial	1.9%	12	This strategy entails that Sabah peruses global climate finance funding in particular the funding available for green projects. While this is currently a lower priority, it can be accelerated through the use of grants and blended finance which lowers costs (World Bank, 2020; UNEP, 2021).

WO2	Collaborate with foreign energy companies	3.3%	9	This strategy entails that Sabah peruses global climate finance funding in particular the funding available for green projects. While this is currently a lower priority, it can be accelerated through the use of grants and blended finance which lowers costs (World Bank, 2020; UNEP, 2021).
WO3	Deploy adaptable technology based modular	2.2%	10	The use of portable solar and wind units exemplifies modular systems which are versatile and particularly beneficial in remote locations in Sabah. Although practical and affordable, this approach is not emphasized. Research recommends these options for more expeditious and simpler energy access (IRENA, 2019; IEA, 2020).
WO4	Shift global perception to attraction international investors	1.6%	13	A shift in perception by investors will enable more funding to flow towards Sabah. Nonetheless, this move is considered low priority. Marketing Sabah's ecological undertakings at the international level could expand attention as well as funding opportunities (OECD, 2011; UNEP, 2021).
WT1	Supply chains must incorporate redundancy	1.9%	11	Avoiding delays hinges on strengthening supply chains. This approach may be of lesser importance but is nonetheless relevant given the mounting global risks to the supply chain. To mitigate the risks, local sourcing and back-up plans can be employed (KPMG, 2019).
WT2	Employ regulatory tools to shield long term	0.9%	15	This strategy aims at making green investments more secure and less volatile through the use of governance frameworks and policies. While not emphasized at the moment, it is evident that gaining investor interest is aided through robust regulations which minimize risks (IRENA, 2019).
WT3	A centralized digital monitoring system	0.9%	16	Digital technologies, including information technologies, enable monitoring for progress optimization and system efficiency at all levels. Although this is the lowest-ranked strategy, digital monitoring further aids transparency and effectiveness (IEA, 2020).

WT4	Enhance skill localization to limit expo	1.0%	14	Educating local individuals on the operation of green technologies creates new job opportunities while simultaneously meeting domestic skillset needs and decreasing dependence on foreign specialists. This approach, while not prioritized, is critical for sustainable success (World Bank, 2020; ADB, 2022).

6.1 Important Evaluation along with Strategic Analysis

Adored in excess of five years, Superintendencies has followed a set of priorities on its own efficiently governing their green investments and energy development. As whitened in these strategies, they are well constructed towards fundamental advancement, investment attraction and improvement of regulations. These underscore elements reveal strong alignment of achieving the two ultimate goals underweight strategic objectives SO1, Create opportunities of strategic concern weighted at 20.8 and SO2 Market and position Sabah for green investment type weighted to 19.2 percent, which combined caps to 40 percent share of the strategic core objectives and focuses set forth. This signifies strategic intent tending towards the foundation enabling for rich shafts of green capital and the sustainable growth. These niches are extremely important while undertaking a green energy venture with regards to building a credible ecosystem and global investor optimism. Hence, both are needed for the prolonged economic stability and sustenance.

The optimization of focus areas with percentages under 20% like endorsing through the Environmental Compliance System (ECoS) Utilization (15.3%) and SO4: Stakeholder Engagement Hybrid Campaign Leadership (10.5%) shows Sabah's continued prioritization on improving governance and stakeholder relationships. The digitization of tools like ECoS fulfills environmental governance requirements in the same way best practices advocate for the use of technology in promoting efficiency and transparency in the execution of policies (UNEP, 2021). In addition, hybrid stakeholder campaigns indicate a shift towards active participation in policy execution that is linked with greater compliance and resilience of projects to threats (IEA, 2020).

For all these advantages, an examination of the underdeveloped weighting of Weaknesses-Threats (WT) and Weaknesses-Opportunities (WO) shows a clear strategic imbalance. The total weighting of the WT strategies is below 5% and in the case of WT1: Supply chain redundancy should be added (1.9%) and WT4: Skill localization enhancement (1.0%), lowest ranked priorities. This may indicate an operational myopia regarding vulnerability gaps, human capital constraints, or both. These risks are particularly relevant when considering the current volatile environment of global supply chains and the fast-changing landscape of green technology. Studies emphasize that building resilience through local skill and infrastructure redundancy should make up a greater share of budget allocation—especially in developing economies adopting new sustainable systems (KPMG, 2019; IRENA, 2019).

Likewise, opportunities associated with international financing and partnerships appear to be underutilized. WO2: Collaborate with foreign energy companies (3.3%) and WO1: Utilize international grants (1.9%) are relatively low on the strategic hierarchy, remains weak on the strategic focus tier, even with climate finance accessibility on the rise. The World Bank (2020) reports that climate finance is surpassing USD 600 billion per year, featuring public-private funding funnels. Sabah’s lack of climate funding engagement represents a significant strategic

disadvantage. Increased attention towards foreign partnerships could facilitate access to specialized knowledge, investment, and technological advancements, expedite project timelines, and lower operational costs (ADB, 2022; IEA, 2020).

In terms of governance, Sabah shows a clear top-down strategic focus. The rationale behind ST1 Control domineering regulatory oversight and SO3 Centralized endorsement structures suggests increased state burden coordinating steering functions on the green economy. This level of policy coherence, while effective, could be enhanced through some level of bottom-up integration. As ST3: Establishing local partnerships (4.2%) and ST4: Bundled renewables deployment (4.8%) hint toward more diverse adaptation, they provide certain insights into community solutions. Governance participative, concerning the involvement of local stakeholders throughout the project lifecycle, is increasingly seen as essential for fostering resilience and context-appropriate solutions (UNEP, 2021).

To sum up, Sabah's five year strategic framework shows commendable achievements in constructing the institutional and marketplace infrastructure for green investment. The focus on opportunity creation, marketing, and reducing regulatory hurdles is consistent with global benchmarks. As noted earlier, the strategy suffers from an over-concentration imbalance that increases focus on managing international collaborations, local capacity building, and other risks while diverting attention from expanding focus areas. Fortifying these domains will be critical in enabling Sabah to not only attract investments, but also sustain it through resiliency, efficiency, and community stewardship.

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