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Analysing dimensions and indicators to design energy education framework in Malaysia using the analytic hierarchy process (AHP)

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Abstract

In order to progress towards a more sustainable energy future, Malaysia should reduce its reliance on fossil-based energy sources and shifting to green and renewable energy. Therefore, focus on energy education awareness programmes emphasising sustainable behaviours and frameworks are required. These programmes connect with Sustainable Development Goal 7 of the United Nations, which is to provide affordable and clean energy. In this study, dimensions and indicators of a framework for energy education were studied and evaluated in an effort to improve decision making. This study systematic approach comprised a review of relevant literature and consultation with an ad hoc panel of energy education experts via surveys, interviews, and questionnaires. This study also included an analytic hierarchy process to evaluate the framework's criteria selection, alternative indicators, and priority or weights. The results indicated that the "Aim to minimise climate change" dimension is deemed the most essential criterion for selecting energy education dimension criteria. On the other hand, "National policy makers" is the most essential stakeholder across all parties. It has been determined that the use of analytic hierarchy process to the design of the framework for energy education in Malaysia could help simplifies a systematic decision-making process.

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Keywords: Analytic hierarchy process; Energy education; Energy policy; Indicator; Sustainability

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Nomenclature

AHP	Analytic hierarchy process
CI	Consistency index
CR	Consistency ratio
CO_2	Carbon dioxide
EE	Energy Education
GHG	Greenhouse gas
GDP	Gross domestic product
MCDM	Multiple criteria decision making
NGO	Non-governmental organisation
OPV	Overall priority vector
RI	Random index
λmax	Maximum eigenvalue

1. Introduction

Malaysia is blessed with an abundance of resources capable of generating renewable energy. However, Malaysia's growing energy consumption continues to rely heavily on fossil fuels as a driver of its economy, which undoubtedly contributes to rising global greenhouse gas (GHG) emissions. The continued consumption of fossil fuels could be attributed to a lack of awareness regarding the importance of energy-saving, energy-use behaviour, and a lack of appropriate energy education (EE). To reduce carbon dioxide (CO_2) emissions and energy consumption, the government has set a target of a 45% reduction in the carbon intensity of gross domestic product (GDP) by 2030 [1].

EE is an essential component of the science curriculum. It includes knowledge of the history and types of energy, fossil fuels, GHG emissions, climate change, future energy generation, and environmental impacts. This knowledge could potentially influence how the new generation views energy [2]. EE could be integrated into modern educational technology, making it more accessible and affordable [3].

Developed nations such as the United States, Japan, the United Kingdom, and Australia have already included renewable energy advances into their secondary education curriculum design [4]. A transition to an integrated EE system is critical to meeting mitigation targets in Asian developing countries, with China, Taiwan, and Singapore leading the way [5].

As a developing country, EE is vital to Malaysia's rapid economic growth. Energy is about decision making, and EE is crucial in equipping students with the fundamentals for implementing intelligent and forward-thinking policies. EE is studied worldwide for many reasons. Therefore, a practical and locally relevant sustainability evaluation approach is needed [6].

In this study, we will investigate the development of EE in Malaysia to formulate a framework. This study built the dimension framework utilising AHP, which is a systematic technique for organising and analysing complicated decision criteria to rank sustainability indicators before translating them into a suitable weighting system based on pre-determined criteria [7]. AHP is used to analyse and organise complicated situations by comparing aspects at several levels [8] and prioritising many dimensions and indicators.

Education is a worthwhile effort to promote EE to students, which aids in breaking down barriers since energy awareness and values are primarily shaped during childhood [9]. People, scientists, companies, and decision-makers worldwide have worked together to develop these globalised energy policies and economic structures. This initiative reminds us that energy literacy should be highlighted because community members who are energy-literate can make good decisions when faced with complicated and confusing situations. [10].

As a result, energy literacy has been extensively covered in the literature, with a focus not only on scientific knowledge but also on physical and biological processes, energy flow and earth systems, economic perspectives, and energy decisions. In recent years, EE measures based on the fundamental categories of knowledge, attitude, and behaviour have been established. In several research, however, the information was altered. Other concepts, such as a lifestyle or civic duty, were included. Some research also presented a distinct educational criterion for the curriculum programme [11]. Every single member of society who relies on the usage of energy on a daily basis must make the option and selection to prioritise energy efficiency. In Malaysia, the community environment for creating EE is still ad hoc, and we need a framework for EE and sustainability programmes.

Several surveys and studies have suggested implementing EE into a curriculum that emphasises energy-related knowledge. The level of EE is comparatively related to the importance of energy-related issues in society's day-to-day life experience. In this study, accessing the framework specifying the criteria will embrace a broad EE benchmark. This study also identified its dimension and indicator of criteria, as well as stakeholders executing a necessary action to promote and improve EE systems in Malaysia. Other research has suggested that the behaviour dimension of EE be investigated, as this could develop citizens' responsibilities to cultivate energy conservation [12].

Recently, energy-saving has become one of the most critical issues in Malaysia. The concept of EE could lead to more energy-secure daily behaviour in the future, as well as the concept of conservation as the primary educational goal. Based on a study in Taiwan, a devising framework for EE using the analytic hierarchy process conducted curriculum design framework and evaluation methods captured the idea of energy conservation and carbon reduction [13].

EE goals are based on enhancing energy knowledge, reducing energy consumption, and understanding the current energy crisis in nations. Subsequently, developing individual behaviour and knowledge will tackle the energy crisis. The stakeholders' engagement in the implementation of EE policies may aid in the achievement of the goals. Investigating a dimension in Malaysian EE will propose a new approach, indicate students' interest, and explore potential opportunities and challenges for many energy decisions.

Therefore, this study attempts to assess the general EE criteria, stakeholders, panel judgement and provides a detailed basis for EE, as well as an effort to identify potential methodologies and tools. Additionally, this research could serve as a national pilot for determining EE in school students. The findings of this study will provide baseline data for the development of appropriate energy conservation and sustainability education programmes.

It is important to note that Malaysia is not in the top tier of green energy producers globally. The country's tropical location is conducive to solar power, and its extensive forests can produce ample biomass. Despite this, the government continues to rely significantly on fossil fuels to meet all of its requirements. This circumstance is unfavourable given the current economic and environmental atmosphere, in which many industrialised nations are attempting to apply renewable energy to their overall energy requirements [14].

Malaysia's modern coal-fired power plants employ high-quality coal, yet they nonetheless burn massive volumes of fossil fuel daily. Regardless of technology, coal-burning power plants are major polluters. The industry pollutes local ecosystems with mercury, arsenic, lead, nitrogen oxide (a smog contributor), sulphur dioxide (a component of acid rain), and other dangerous substances, as the pollutants contain huge amounts of CO_2 that lead to GHG. In addition, environmentalists still argue that the concept of "clean coal" is unattainable [15].

Although renewable energy can generally compete with oil and gas effectively, the country's existing coal-fired thermal plants continue to operate as usual since coal is a cheaper fuel source for electricity generation. However, burning coal has several externalities, such as negative environmental and public health costs, that are not fully acknowledged, let alone factored into electricity pricing [16]. If the government fails to reconsider today's energy choices in the coming years seriously, this situation will throw the country into a higher carbon emissions trajectory due to its reliance on coal. As a result, the country contradicts the Paris Agreement commitments, which call for governments to transition to low-emission, long-term strategies.

The majority of scientists and policymakers acknowledge that the rate of CO_2 emissions and other greenhouse gases is related to global warming. If we want to restrict global warming to less than 2 °C over pre-industrial levels, carbon-based energy sources must be drastically reduced [17]. The Paris Agreement (2015), the most recent in a series of summits and conferences aimed to coordinate a cohesive response to the global warming challenge, represents this objective (Green Technology Master Plan, 2017–2030). It was adopted by all UN member states in 2015, with the 2030 Sustainable Development Goals (SDGs) as its primary driver. It also presents a blueprint for the future of humanity and the earth. The 17 SDGs contain an urgent call for countries to collaborate to promote education and combat climate change.

The second motivator stems from Malaysia's education system have recently been criticised and seriously questioned regarding its direction. Goal 7 of the SDGs ensuring affordable and clean energy to all as countries continue to improve access to affordable, reliable, sustainable, and modern energy. Despite the government's emphasis on energy efficiency, such as transmission into renewable energy, energy projects are the most complex because renewable energy is important to sustainable growth. With similar concepts, the suggestion constructed on EE conceptual framework could benefit the key stakeholders' group engagement, which might influence successful implementation.

In order to apply the EE framework successfully, ongoing dialogue with stakeholders will result in an analysis that is both clear and consistent. Stakeholder participation that is effective is quickly becoming into a professional practise to enhance project performance [18]. As a result, the limitations of the existing research and the gaps in stakeholder engagement implementation, especially in Malaysia's renewable EE, serve as the foundation for this study. The performance of renewable EE and projects can still be improved, but there is still a need for a verified and trustworthy framework for stakeholder participation [19].

By identifying imperative constructs of stakeholder interaction in the context of projects and analysing the relationship between identified constructions and the success of renewable energy projects, this study intended to close the gap. The conceptual structure was created from earlier literature and tested in the market for renewable energy. The results of this study will help the major stakeholder groups in energy efficiency by creating a framework for successfully implementing renewable EE. In addition, this study enhances the scant body of knowledge on the components of stakeholder involvement that affect the success of renewable energy by using Malaysia as a case study and providing some crucial insights into stakeholder engagement among scholars globally.

The EE framework was previously studied using a variety of multiple-criteria decision making (MCDM) techniques. The MCDM techniques offer a chance to assess the framework and other competing aspects. The methods could also ascertain which option, when compared to other alternatives, best fits a given set of criteria and offers the greatest advantages. For all of the aforementioned reasons, MCDM is a great tool [20].

In Taiwan, due to the depletion of local energy resources, effective energy use has become one of the country's environmental issues [21]. The government revised its energy policies to promote the use of sustainable energy. In 2007, the Cabinet adopted the 'Energy Conservation and Carbon Mitigation' action plan in line with the Renewable Energy Policy Process. According to research, incorporating carbon mitigation into the curriculum will improve locals' understanding of energy conservation and related activities. The development of EE curricula and evaluation techniques has been the subject of numerous studies and research projects. These efforts do not, however, take a full look at the educational goals for raising energy literacy.

By engaging an ad hoc panel of energy and education specialists and evaluating published studies, the research developed an EE framework that captures the concept of carbon reduction and energy savings. The framework's indicators and their weights are determined by the methodology using the AHP. According to the research, the most important educational objectives for energy are "low-carbon living" and "civic responsibility for a sustainable society". The first and second indicators on the list are "awareness and self-efficacy" and "identification of carbon-free technologies and action plans", respectively [22].

Despite the government's promotion of formal (Ministry of Education Malaysia, 2002) and informal (Ministry of Energy, Green Technology and Water Malaysia (KeTTHA), 2009) EE education, students' energy literacy was disconcertingly low in a different comparative study of secondary students in Malaysia. The findings made clear how crucial it is to enhance EE curricula in Malaysian public schools by include more information on current affairs and relevant topics, like daily energy consumption [23].

Prior studies suggested that MCDM approaches might help decision-makers and stakeholders resolve some environmental decision-making issues [24,25]. The results also demonstrated a growing interest with prior researchers in using these methods to advance various stages of sustainable and renewable energy systems. So, in this study, AHP will be utilised to assess the criteria and stakeholders that are most practical for the EE design framework.

2. Methodology

There are two categories in the AHP model used in this study; hierarchy design and hierarchy evaluation (Fig. 1). In the first phase of AHP, the selection of EE priority criteria and stakeholders who influenced the selection were completed. Meanwhile, the second phase was the derivation of criteria weightage and local priorities of each stakeholder, followed by evaluating the most feasible stakeholders. They played an essential role in implementing the EE framework.

Total of 385 assessment sub-themes of criteria were collected, compiled, stirred, and filtered to identify and determine the dimension and indicator. Fourteen assessments of potential criteria themes were identified and finalised for the expert panel selection process. Subsequently, the stakeholder's engagements in Malaysia were identified

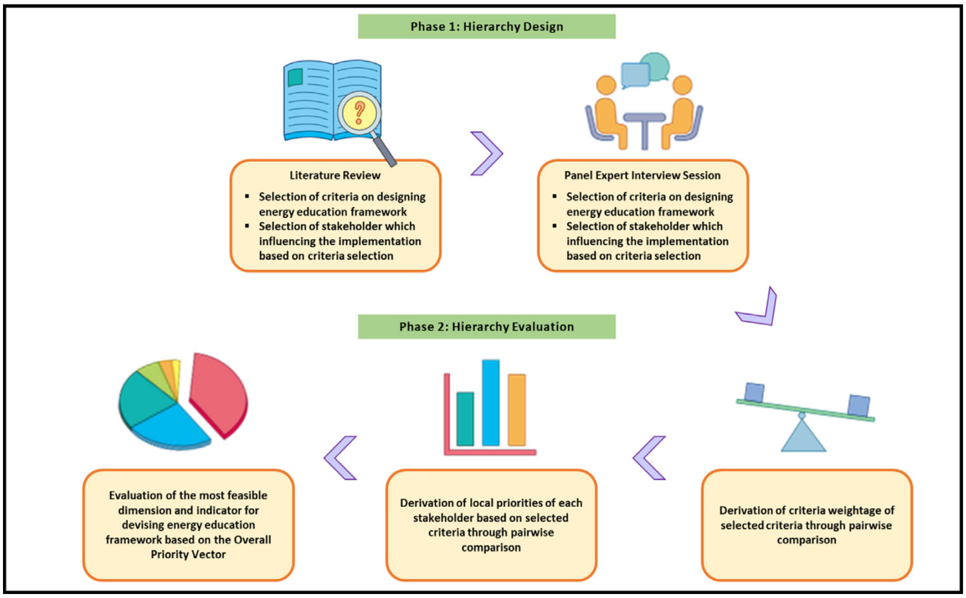

Fig. 1. Overall flow of methodology.

Table 1. List of stakeholders.

Number	Important stakeholders in implementing energy education in Malaysia
1	NGO
2	Schools
3	Regional and local government
4	Individual
5	Community
6	National Policy Makers
7	Research institution
8	Higher education institute
9	Energy companies

through literature reviews (Table 1). Based on that, a total of 14 criteria and 9 stakeholders' indicators were identified. Decision-makers and stakeholders may use the decision's outcome to establish subjective EE measures to evaluate the most feasible criteria and stakeholders in Malaysia's EE framework implementation. Two sets of data, criteria selection, including weights for the assessment criteria, and performance score-based EE framework were collected, normalised, and ranked.

Developing an EE framework was based on the criteria determined through a survey of panel experts across performance scores obtained through interviews. The interviews involved energy domain experts who were asked to rank the elicited dimensions and indicators [2]. In this study, the panel of experts comprised of 7 professionals, including science teachers from both private and public schools who specialise in syllabus development, environmental education, and science education, as well as a professional who is involved in research on the promotion of EE in the Malaysian curriculum.

This study used a questionnaire survey to gather data, and a newly selected group of experts was asked to rank the list of indicators that the review panel had examined and validated. The literacy framework, which consists of 7 dimensions and 9 indicators, was used to design the questionnaire. According to the method [19], each question will be graded on a scale of 1/9 (least desired), 1 (equal), or 9 (most favoured) (Table 2).

The results seek to prioritise the Malaysian EE framework's dimension and indicator. This novel strategy would be effective since, as recommended, it calls for the participation of a substantial key person from a crucial dimension.

Table 2. Intensity scale for criteria pairwise comparison.

Relative importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to objective
3	Weak importance	Experience and judgement slightly favour one activity over another
5	Strong importance	Experience and judgement strongly favour one activity over another
7	Demonstrated importance	One activity is strongly favoured and demonstrated in practice
9	Extreme importance	The evidence favours one activity over another is of highest possible order of affirmation
2, 4, 6, 8	Intermediate values	When compromise is needed between two adjacent judgements

Using the paired comparison scale based on the method, the pairwise comparison was performed during the second phase of AHP [19]. The weighting of the specified criterion and the local priority of each preference depending on the selected criteria were established as a result of the AHP computation. The values assigned in the pairwise comparison matrix was mostly decided by experts. To lessen biases in this study, the consistency was tested before moving on to the next step. Finally, based on the overall priority vector (OPV) determined by calculation, the evaluation of the various practicable and preference weightage criteria and stakeholder EE framework implementation were carried out. Stakeholder and practicable criteria with the highest OPV were found to be the most suitable for creating the EE framework in this study.

After the problem decomposition and hierarchy development stages, the second step of the AHP process defined the priorities for the chosen criteria. This procedure is essential because not all study criteria will be of equal importance. Thus, based on the findings of experts, their relative value was ascertained by pairwise comparison.

The total of each column's numbers was then used to compute the matrix's normalisation [15]. The column sum is then divided by each column entry to produce the normalised score for that column. Each column's total is 1.000. The decisions made during priority derivation were typically subjective. Consistency analysis is therefore necessary to lessen the biases of the model.

Determining local priorities for chosen stakeholders (alternatives) is the third phase in the AHP process. This step compares the alternatives based on the provided criteria, and then it determines the relative preferences of the stakeholders for each criterion [17]. In other words, the relative importance of the alternatives to the 7 criteria was established. These preferences, which are known as "local priorities", are only valid for each particular criterion. For each criterion in the decision-making model, a pairwise comparison of all the other possibilities has been done. Then, based on their degrees of dominance and the specific criteria in the upper level, all the criteria in each level were compared pairwise [17]. According to pairwise comparison scale in the method, several pairwise comparisons were performed (shown in Table 3) [19]. This scaled comparison contains nine levels, with 1 denoting equal importance, 3 indicating moderate importance, 5 denoting strong importance, 7 indicating demonstrated importance, and 9 signifying extreme or absolute importance. Meanwhile, values 2, 4, 6, and 8 are questionable comparisons of two neighbouring values.

Table 3. Pairwise comparison matrix of criteria.

Criteria	1	2	3	4	5	6	7
1	1	4	3	4	9	9	3
2	1/4	1	1/2	2	4	9	2
3	1/3	2	1	3	5	9	2
4	1/4	1/2	1/3	1	4	9	1/3
5	1/9	1/4	1/5	1/4	1	3	1/6
6	1/9	1/9	1/9	1/9	1/3	1	1/9
7	1/3	1/2	1/2	3	6	9	1
Criteria weight	0.3667	0.1450	0.1953	0.0939	0.0350	0.0189	0.1453

Criteria: 1. Aim to limit Climate Change, **2.** Design of energy curriculum to develop multi-skills students, **3.** Awareness towards energy security among the community, **4.** Sustainability education is not complete without energy education, **5.** Provide essential skills for energy education, **6.** Effort to encourage smart energy citizens, **7.** Multidimensional view on energy to understand the complexity of energy in new ways.

At this point, a hierarchy of goals, criteria, and alternative frameworks derived from stakeholders' overall priorities at this stage has been generated. The weight was calculated based on the ranking process criteria for the desired goal. The hierarchy's predicted judgement was checked for consistency, and a fair level of consistency was ensured in determining local priorities for the stakeholders (alternatives).

After acquiring the local priorities that identify the preferred alternative for each criterion, model synthesis is a procedure that determines the overall focus for each option. The local priority of each choice serves as the basis for the calculation. In addition, the relative importance of each criterion is taken into account. The best option is used to establish the overall priority after model synthesis adds up all possible priorities as a weighted total to account for the weight of each criterion. The reasoning behind the outcomes was then determined by analysing the results. The option that is preferred to the study's chosen criteria can be identified using the Overall Priority Vector (OPV) computation. As a dimension of the criteria and indicator EE framework, it is most recommended since it has the highest OPV among stakeholders.

The weights determined for each criterion have a significant impact on the OPV, which is the sensitivity analysis procedure. To ascertain how the outcomes may have changed if the criteria had been different, sensitivity analysis is used. The final step in the AHP process is this analysis, which helps us determine how solid our first choice was and what the criteria were. No final decision should be made without first going through the process of sensitivity analysis. Making a decision based on the objective established at the start of the investigation is the last step in AHP analysis. Once the aforementioned actions have been taken, the final decision can be made. This phase involves comparing the overall priorities that have been collected and assessing whether the differences are substantial enough to allow for a clear decision [17].

Decision modelling, which uses AHP analysis to create a decision hierarchy, is the first step in creating a framework model. To analyse the decision or consequences, it merely entails building a hierarchy. The AHP, an analytical hierarchy process, hierarchically structures the issue. In our investigation, a sample hierarchy was suggested. The model is shown in Fig. 2, where the first level represents our goal of Reduction Global Limit Change. The criteria represent the second tier of the hierarchy used to reduce GHG emissions.

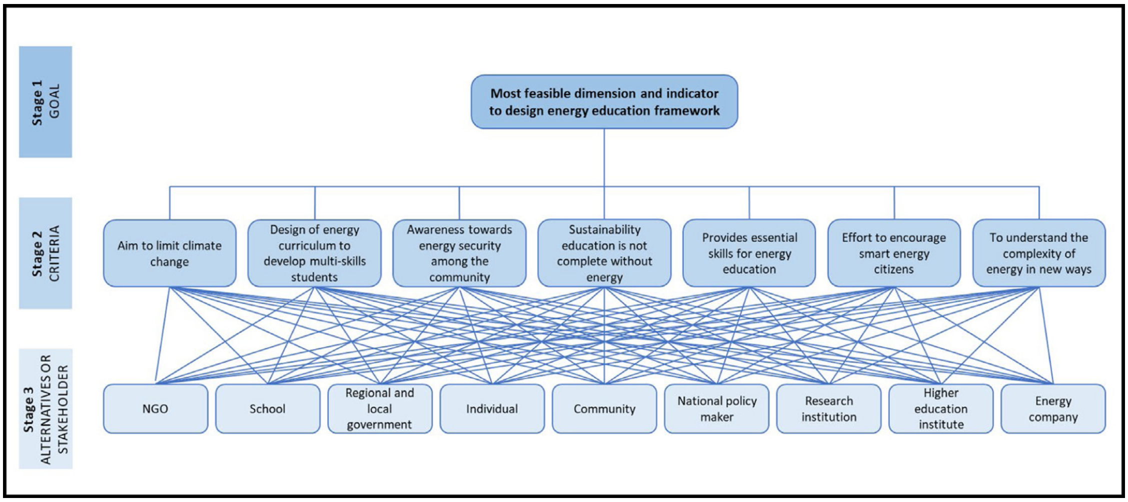

Fig. 2. The hierarchy proposed most feasible dimension and indicator to design energy education framework.

It is clear how these hierarchical principles are advantageous. By structuring the issue in this way, it is possible to better comprehend the option that can be made, along with the standards and potential solutions to compare and contrast. This is important because a more difficult or multi-criteria decisions would call for the involvement of specialists to ensure that the criteria and potential alternatives have been taken into account. In some research that calls for more exact findings, there can be a need for additional hierarchy levels, such as sub-criteria.

3. Results and discussion

3.1. AHP findings

Through pairwise comparison, experts' outcomes in determining priority for particular criteria were established based on our findings. A standard scale (Table 3) with 9 levels is used in AHP multiple pairwise comparisons to reflect the degree of preference for one element over another. However, the judgement used to derive priority was typically arbitrary. Consistency analysis must therefore be carried out in order to lessen the model's biases. The initial preference rankings must hold steady. Calculating the random index (RI), the consistency index (CI), and the consistency ratio (CR) are the three primary steps (Table 4). This consistency check for the pairwise comparison is calculated based on the equations in Ilham and Nimme [15].

Table 4. Results of AHP computation for criteria.

Criteria	Criteria weightage	(λmax), CI, RI	CR
Aim to limit climate change	0.3667		
Design of energy curriculum to develop multi-skills students	0.1450	λmax = 7.51052	CR = 0.0644
Awareness towards energy security among the community	0.1953	CI = 0.01052	
Sustainability education is not complete without energy education	0.0939	RI = 1.32	
Provide essential skills for energy education	0.0350		
Effort to encourage smart energy citizens	0.0189		
Multidimensional view on energy, to understand the complexity of energy in new ways	0.1453		

The methodology states that the AHP analysis can only go on if the computed CR is 0.10 or less. Any higher score implies that the warrant should be re-examined [15] in order to determine local preferences for certain alternatives (stakeholders). Table 5 displays the model synthesis of stakeholder criteria. The stakeholders are compared using the stated criteria in the third phase of AHP, and then their relative priority for each criterion are determined. Table 6 lists the stakeholders along with their overarching priorities.

Table 5. Model synthesis.

Stakeholder	Aim to limit climate change	Design of energy curriculum to develop multi-skills students	Awareness towards energy security among the community	Sustainability education is not complete without energy education	Provide essential skills for energy education	Effort to encourage smart energy citizens	Multi-dimensional view on energy, to understand the complexity of energy in new ways	Overall priorities
Criteria weights	0.3667	0.1450	0.1953	0.0939	0.035	0.0189	0.1453	1.0000
National policy makers	0.2498	0.2473	0.0803	0.1310	0.0259	0.2426	0.2428	0.1962
Individual	0.0221	0.0189	0.1396	0.0821	0.3567	0.1707	0.0188	0.0643
Regional and local government	0.1857	0.1873	0.2085	0.0434	0.0409	0.2876	0.1878	0.1742
Schools	0.0377	0.0401	0.1247	0.0719	0.2124	0.052	0.0396	0.0649
Community	0.1419	0.1486	0.0466	0.1965	0.0480	0.035	0.1579	0.1264
Research institution	0.1310	0.127	0.0676	0.1591	0.0593	0.0807	0.1249	0.1163
Higher education institute	0.0631	0.0663	0.0843	0.1498	0.0982	0.0902	0.0642	0.0778
NGO	0.1087	0.1057	0.0975	0.0841	0.0703	0.0163	0.0993	0.0993
Energy companies	0.0600	0.0587	0.1507	0.0820	0.0883	0.0249	0.5592	0.1525

The results obtained from highest to lowest were as follows: aim to limit climate change (0.3667), awareness towards energy security among the community (0.1953), to understand the complexity of energy in new ways (0.1453), design of energy curriculum to develop multi-skills students (0.1450), sustainability education is not complete without EE (0.0939), provide essential skills for EE (0.0350), and effort to encourage intelligent energy citizens (0.0189) (Fig. 3).

Table 6. List of stakeholders with their overall priorities.

Stakeholders	Overall priority	Percentage, %
National policy makers	0.1962	19
Regional and local government	0.1742	16
Energy companies	0.1525	14
Community	0.1264	12
Research institution	0.1163	11
NGO	0.0993	9
Higher education institute	0.0778	7
Schools	0.0649	6
Individual	0.0643	6

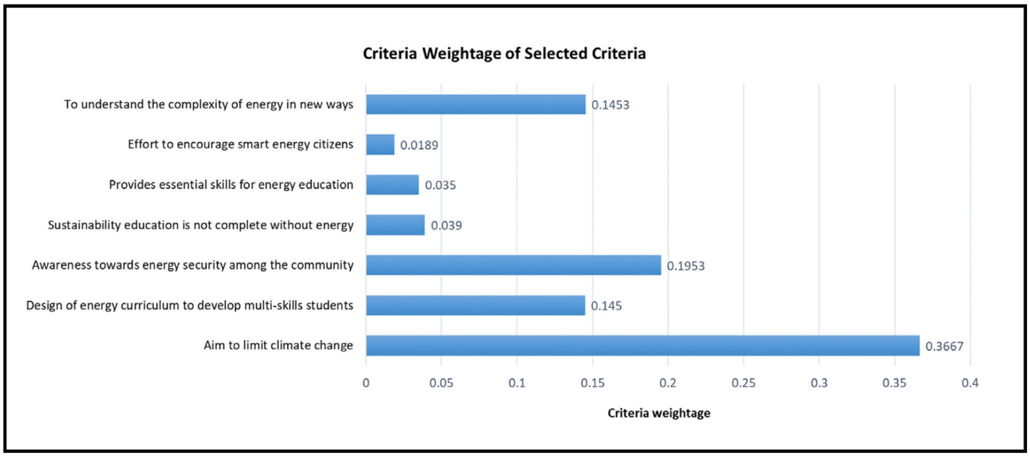

Fig. 3. Criteria weightage of selected criteria.

In other words, given the importance of each criterion, National Policy Makers are preferable (overall priority = 0.1962), followed by regional and local governments (overall priority = 0.1742), energy companies (overall priority = 0.1525), communities are in medium weightage (overall priority = 0.1264), followed by research institution (overall priority = 0.1163), NGO (overall priority = 0.0993), higher education institute (overall priority = 0.0778), schools (overall priority = 0.0649), and individual obtain the least weightage (overall priority = 0.0643) (Fig. 4).

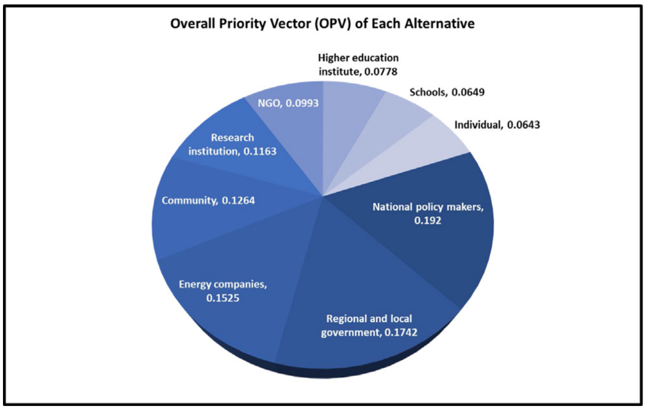

Fig. 4. Overall Priority Vector (OPV) of each stakeholder (Alternatives)

3.2. Dimensions and indicators of energy education framework

Through a quantitative examination of several segments utilising a priority estimation model, this study explores potential dimensions and indicators in developing an EE framework in Malaysia. The most practical standards for creating Malaysia's EE framework have been determined using the AHP model as an MCDM tool. This methodology aids in arriving at a logical decision based on a careful evaluation of pertinent factors. The predesign of the framework is shown in Fig. 2, which includes three tiers in the AHP hierarchy: Goal, Criteria, and Alternatives (stakeholder).

The outcome of the interview with specialists in EE research and development had a considerable impact on the outcomes that were reached. Seven criteria were developed with various priorities based on their expertise and professional judgements: aim to limit climate change (0.3667), awareness towards energy security among the community (0.1953), to understand the complexity of energy in new ways (0.1453), design of energy curriculum to develop multi-skills students (0.1450), sustainability education is not complete without EE (0.0939), provide essential skills for EE (0.0350), and effort to encourage smart energy citizens (0.0189). These criteria served as the foundation for selecting the most potential influence stakeholders, such as National Policy Makers, Individual, Regional and Local Government, Schools, Community, Research Institution, Higher Education Institute, NGO, and Energy Companies.

Of the 9 stakeholders selected through the questionnaires and survey session, they undoubtedly have the most critical value in implementing EE in Malaysia. However, based on the criteria established, this study highlights the National Policy Makers as the most feasible stakeholder, with an overall priority of 19%. Meanwhile, the preference for Regional and Local Governments (overall priority = 16%) and Energy Companies (overall priority = 14%) to be picked as decision-makers is nearly equal. Individual and School, on the other hand, have the lowest preference and similarity scores according to the computed OPV (overall priority = 6%). Fig. 5 displays the stakeholders' priorities weighting in relation to the chosen criteria.

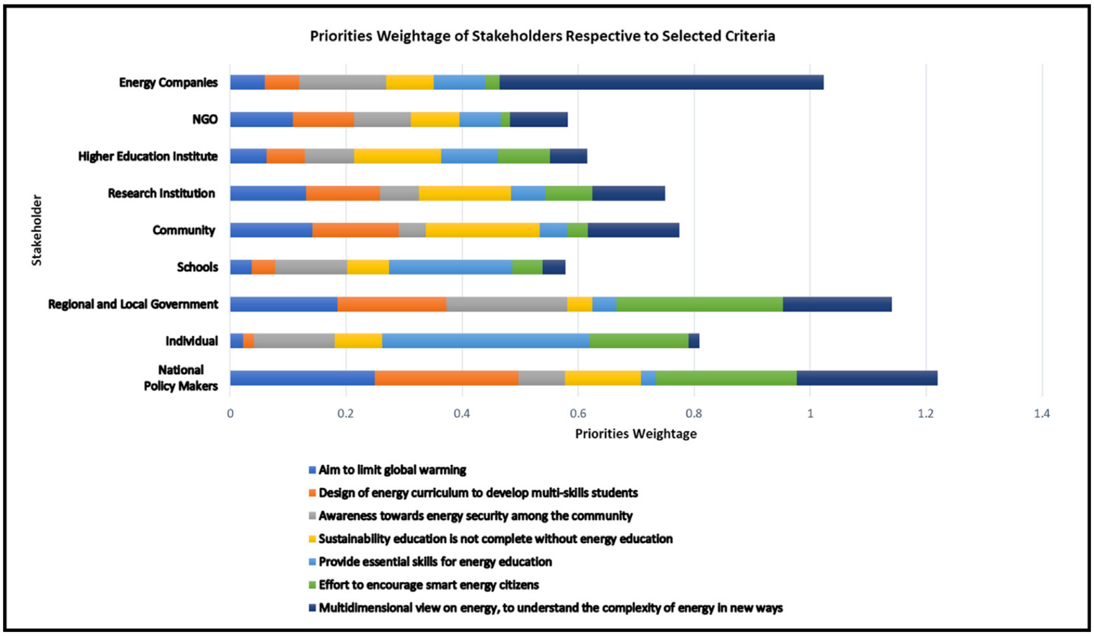

Fig. 5. Priorities weightage of stakeholders respective to selected criteria.

In this study, the research objectives were to review related literature and interview panel experts in EE to determine the dimensions and indicators for an EE framework. Therefore, 7 criteria were selected, and aimed to limit climate change was found as the most critical dimension and to score the highest rank based on the pairwise comparison. The results show that global climate change is urgent, and Malaysia's energy policy challenges are more critical to panel experts to be considered during judgement. For the next 30 years, they think that the national development and sustainability plan should prioritise energy innovation. It also represents alternatives for diversifying energy sources and upholding GHG emission–reduction commitments made by Malaysia, which signed the Paris Agreement (2015). A CR value of 0.0644 (for the proportion of inconsistency CR 0.10) was also obtained after the approach for calculating the weight of the degree of consistency judgement using AHP was confirmed (Table 4). The decision-making process utilising AHP is continued because this judgement matrix is largely consistent.

This study also suggested that the most influential stakeholders play a vital role in implementing the EE framework in Malaysia. Based on the results derived through interviews and AHP, the most crucial stakeholder in implementing the EE framework is the National Policy Makers. According to the respondent judgement, Malaysian policymakers must develop a sustainable, innovative, and financially sustainable energy policy. Panel experts believe that the task for policymakers in emerging domestic climate change and providing an apparent vision direction discovery by promoting energy awareness among citizens is a long-term country's innovation and institutional capacity.

National Policy Makers are the most critical stakeholders in the implementation of any policy in a country. Based on a result obtained in Aim to Limit Climate Change, National Policy Makers must implement policy. In terms of implementing EE policy, the framework flow was almost equivalent to that of other Asian nations including Taiwan, Japan, the United Kingdom, and the United States. However, in certain nations, such as Canada, community and public stakeholders play a critical role in promoting the professionalisation and management of EE in educational institutions and research facilities.

4. Concluding remarks

In conclusion, this analysis showed that environmental concerns, technological disruptions, and changes in consumption patterns are posing serious problems for the country's energy sector. These factors can potentially jeopardise the arrangement that has been a task for Malaysia to limit climate change. Additionally significant are the remarkable transformations in Malaysia's politics. Distributive demands, such as those for fuel subsidies, low energy costs, and lower taxes, may increase with increased political competition and party fragmentation, providing further difficulties for the fiscal stability of national policymakers. It was found in this study that the "Aim to minimise climate change" dimension (0.3667) is deemed the most essential criterion for selecting energy education dimension criteria. The prioritisation of stakeholders in this study was also demonstrated using AHP. On the other hand, "National policy makers" (OPV: 0.192) is the most essential stakeholder across all parties. In order to lessen decision-making bias, consistency checking was also incorporated into the research approach. The study's consistency was 0.0644, which is less than 0.1. The conclusion reached was deemed to be reasonably consistent, permitting the confirmation of the AHP procedures done. This procedure is necessary to demonstrate the validity of findings for the benefit of upcoming researchers.

Way ahead, future studies in Malaysian energy education should compare the results of the obtained AHP with those of other MCDM tools to confirm the priorities that are generated. The methods include Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), Analysis of Variance (ANOVA), Elimination Et Choice Translating Reality (ELECTRE), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Data reliability can be increased by using a variety of ways to determine priority levels. Future research should also take into account more factors affecting the feasible stakeholder selection to get a more complete output.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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