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The Application of Analytical Hierarchy Process in Combination with PESTEL-SWOT Analysis to Assess the Hydrocarbons Sector in Cyprus

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Abstract: Natural gas reserves have been recently found offshore of Cyprus. Hence, a new energy sector is under development, creating potential for raised welfare for the small insular EU member. Several social and economic benefits could be achieved from the resources' exploitation. However, natural gas is a non-renewable energy source, connected with the major environmental issues of fossil fuels. The research goal of this work was to evaluate the sustainability of the new hydrocarbons sector. This was attained using a set of indicators, developed from the combination of PESTEL (Political, Economic, Technical, Social, Environmental, Legal) and SWOT (Strengths, Weaknesses, Opportunities, Threats) analyses. These were quantified using the Analytical Hierarchy Process (AHP) weighting method. They were pairwise compared and evaluated, resulting to a size for each one. The judgements of four evaluators, representing diverse interested parties, were used. The strengths and opportunities of the sector were found to be more than the weaknesses and threats. The relevant indicators quantification demonstrates also that the value of the positives is higher than the negatives. Therefore, if the first are enhanced and the latter are mitigated, there is sustainability potential. The sectors environmental issues are evaluated as the most important, followed by the economic. The other takes lower but comparatively significant values, and must be handled accordingly. These results lead to useful conclusions and could be exploited for decision-making and policies formulation.

Keywords: natural gas; sustainability; PESTEL; SWOT; AHP

1. Introduction

Cyprus is a small insular EU member Country located in the southeastern Mediterranean. The energy system of the island is based on imported oil-fired electricity generation with a limited contribution of renewable energy sources such as solar, wind and biomass [1,2]. Recently, offshore hydrocarbon explorations have detected natural gas reserves in the "Aphrodite" Natural Gas Field. Furthermore, other licenses have been granted to international Oil and Gas companies and related hydrocarbon prospection activities in other areas, within the island Exclusive Economic Zone (EEZ), are underway [3]. Figure 1 presents a map of the exploration blocks that the Country has established and the corresponding licensees [4]. These local energy sources exploitation could increase incomes and strengthen the energy supply security [5] for Cyprus. Such context could be a force for moving toward the economic and welfare growth of the island.

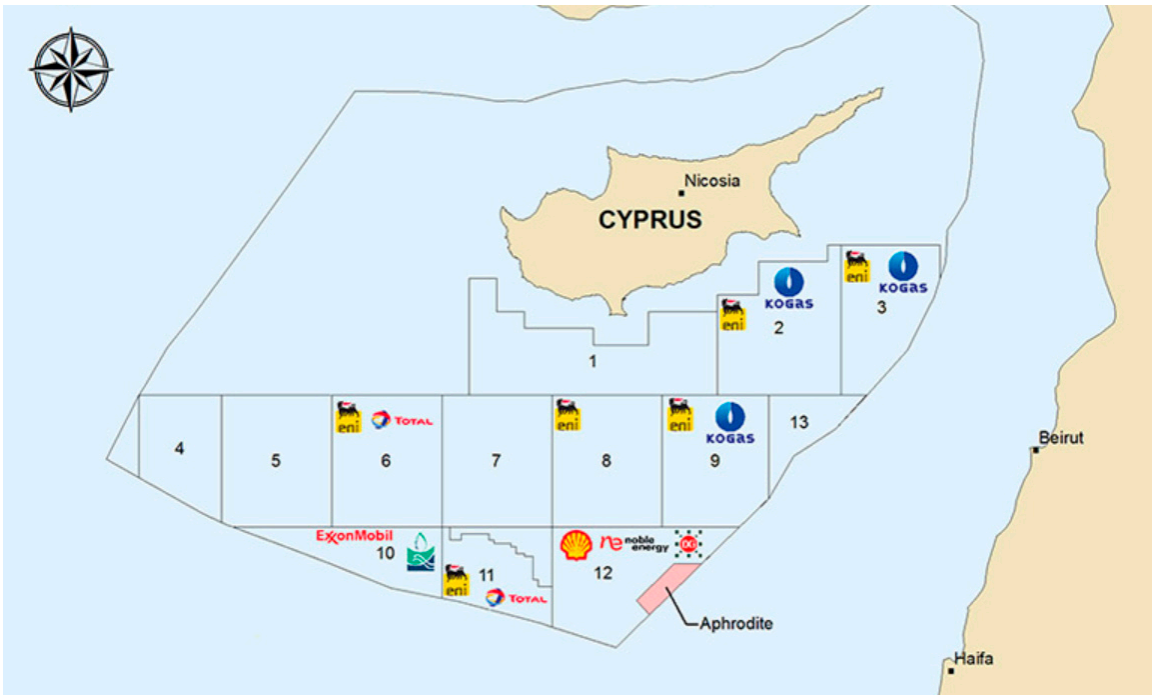

Figure 1. Exploration blocks and the corresponding licenses holders [4].

Natural gas is considered as environmental friendly energy source due to its low pollutant emissions (CO2, CO, nitrogen oxides, particulates, sulfur dioxide) compared to other fossil fuels [6]. However, natural gas extraction and conversion are still connected to several environmental impacts including greenhouse gases (GHG), i.e., carbon dioxide and methane emission, land use alteration and local ecosystem damage [7]. Moreover, fossil fuel such as natural gas, are not renewable and sustainable energy sources and their exploitation is, nowadays, connected to several social, political and economic concerns for producing countries, such as civil war, autocracy, lack of economic development [8] and terrorism [9]. In this context, the sustainability of Cyprus hydrocarbon exploitation is of interest to engineers, scientists, authorities and civil society actors.

Sustainability can be defined as the management of financial, technological, institutional, natural and social resources to guarantee the needs of present and future generations [10]. The related performance can be evaluated by using indicators including policies, decisions and actions to create economic, social and environmental results [11]. These indicators define important characteristics for sustainable development and their availability is a precondition to convert the model into policy [12]. Indicators are the necessary metric to track performance at the horizontal level in sustainability and they provide a comprehensive basis for the assessment of progress against environment, policy, economic, social targets, etc. [13]. According to [14], "*indicators quantify information by aggregating different and multiple data (necessary to obtain reliable information); thus, they can be used to illustrate and communicate complex phenomena in a simpler way, including trends and progresses over a certain period of time*". Furthermore, according to the definition given by the European Environmental Agency (EEA), an environmental indicator is an observed value, representative of a phenomenon under study [15] and "*a measure, generally quantitative, that can be used to illustrate and communicate complex phenomena simply, including trends and progress over time*" [16]. Moreover, indicators can be designed, calculated and measured for different spatial and temporal scales. They also can be used either to compare different systems or the evolution of a system, and are suitable to measure and assess sustainability [10].

Several approaches to determine suitable sustainability indicators are mentioned in the literature. Previous studies and methodologies to select them for plant sustainability evaluation are referred [17]. Literature reviews and expert input to identify them is used for energy planning and management assessment [18]. Literature surveys and stakeholder consultation has been used for solar photovoltaic

assessment [19]. An exhaustive list of system observables, i.e., indicators, has been gathered to model the electricity system of India in order to benchmark its sustainability [20]. Performance criteria and sustainable development pillars, i.e., social, economic and environmental have been used for renewable energy sources project evaluation [2]. Indicators have also be chosen to reflect specific conditions for social sustainability assessments of shale gas in the UK [21]. A tool that is used to measure or to rank the chosen sustainability indicators is the Multi-Criteria Analysis Method, AHP [22–25].

Internal and external context analyses as well as stakeholder opinion considerations are required for effective decision-making. The latest editions of quality management standard, ISO 9001:2015, as well as the environmental management standard, ISO 14001:2015, require organizations to determine the internal and external issues that are relevant to their purpose and strategic direction and the needs and expectations of the interested parties [26,27]. A study of the automotive Original Equipment Manufacturers (OEM) industry and suppliers showed that there is positive correlation between an organization's capability to understand the context and its ability to change and to achieve improved performance and results [28].

PESTEL and SWOT analyses are extensively used tools to analyze context. The first technique is able to guide, throughout its six perspectives, a literature review of the enhancement themes for construction productivity [29]. It has also been used to identify and overcome the obstacles to the development of the waste-to-energy incineration industry in China [30]. The latter was applied to reveal the drivers and barriers in the course of implementing rural building energy efficiency in China [31]. A SWOT analysis approach was also used for strategic management and technology enablement of machine learning and advanced analytics in the oil and gas industry [32]. Furthermore, it has been adopted for collecting opinions of Chinese small and medium companies for the ISO 14001 standard [33]. The literature also includes combinations of these two tools. In a case study for the Colombian electricity industry, PESTEL was implemented for scenario development and SWOT for their analysis of strategy design [34]. Moreover, Multi-criteria decision-making (MCDM) techniques, like Analytic Network Process (ANP) and fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS), have been combined with SWOT for analysis purposes [35–37]. SWOT/PESTEL analysis combination has been used to identify the factors that can be set as criteria in further analyses for alternative solutions using AHP. Such an application was presented as a case study of reconstructing a water intake structure [38].

Energy related research in Cyprus covers a wide range of areas. It includes renewable energy integration [39], the evaluation of relevant projects [2], as well as their potential [40]. Energy demand forecasting has also been under investigation by scholars [41]. Energy efficiency of buildings is another research subject [42]. Moreover, technical issues like the determination of quality properties of low-grade biodiesel and heating oil blends have been researched [43]. Natural gas planning [1] and related energy security [5] have also been research topics. Furthermore, the island energy resources including renewables, hydrocarbons reserves and their sustainability has been qualitatively analyzed and investigated [44].

Hence, a research question regarding Cyprus' hydrocarbon development arises; if their exploitation could enable present Cyprus inhabitants to harvest the potential benefits and improve their life without jeopardizing the future generations' right to a clean environment, social coherence and economic prosperity. In order to answer this enquiry, the institutional, technological, economic, environmental and social framework of the new sector must be analyzed and related performance indicators should be determined and calculated. This paper aims to propose a method combining PESTEL analysis and SWOT analysis in order to determine indicators and to evaluate sustainability performance by quantifying them. This is performed by implementing the weighting technique, which is included in the AHP. The results of the established method for the Cyprus hydrocarbon sector assessment are presented and the derived conclusions are analyzed.

2. Materials and Methods

The proposed method combines quality and quantitative analysis as well as decision-making tools in order to quantify results, which qualitatively emerged. It also enables the involvement of multiple interested parties' in order to ensure objectivity.

2.1. Problem Analysis Method

The PESTEL (or PESTLE) analysis is a popular tool that helps to consider the political, economic, social, technical, environmental and legal environment of an organization to identify the external environment or issues that could have an impact on its operations [45]. The SWOT analysis is a strategic analysis tool, which combines the study of the strengths and weaknesses of an organization, territory or sector with the study of the opportunities and threats in its environment [46]. The combination of them is suitable to analytically imprint and evaluate the situation of a sector. The PESTEL analysis results to an extensive description of the context and all the factors influence the situation under study. Consequently from the SWOT analysis emerges the internal and external issues that either must be enhanced, when they are strengths or opportunities, or mitigated when they are weaknesses or threats (Figure 2).

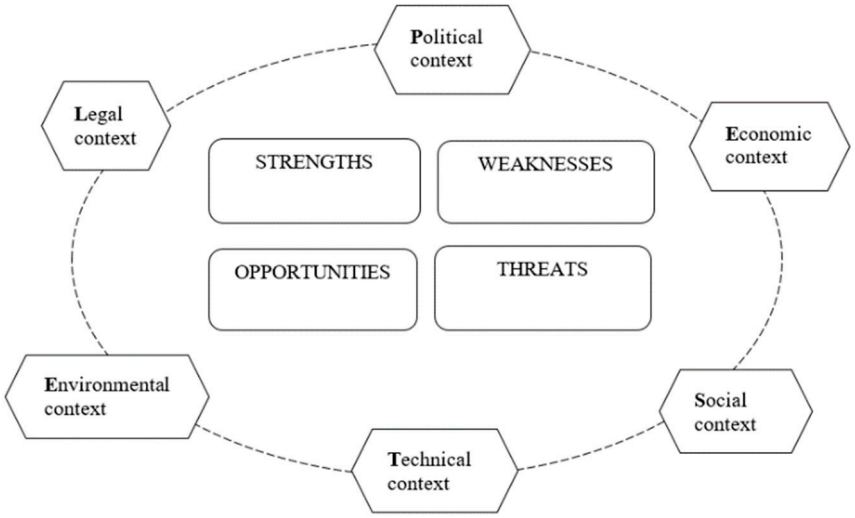

Figure 2. Political, Economic, Social, Technical, Environmental, Legal (PESTEL)-Strengths, Weaknesses, Opportunities, Threats (SWOT) analyses combination.

Saaty's AHP multi-criteria decision-making method proposes to structure an evaluation problem into a hierarchical model [47,48]. Accordingly, Cyprus' hydrocarbon sector evaluation problem was proposed to be analyzed as presented in Figure 3.

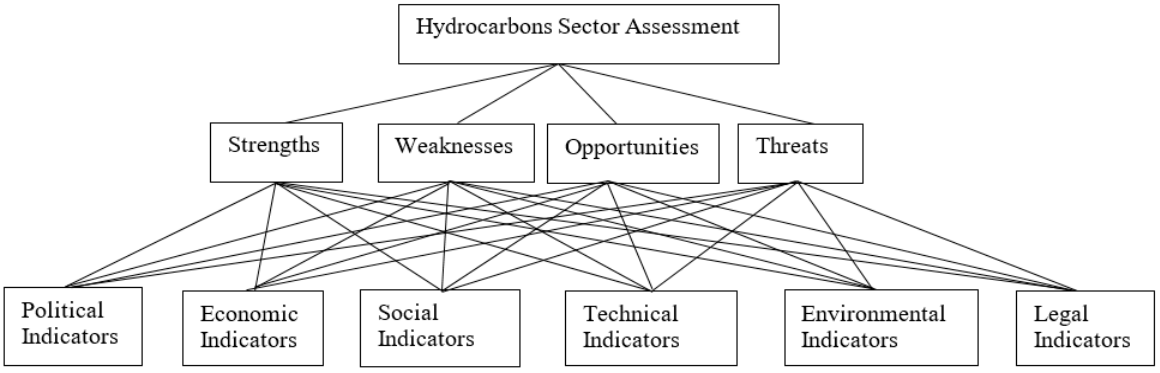

Figure 3. Evaluation problem structure.

Hence, the PESTEL-SWOT combination can be used in order to identify the internal and external issues that can be set as sustainability indicators to cover the external context factors by expressing the strengths, weaknesses, opportunities and threats of Cyprus' hydrocarbon sector and be used to assess its sustainability.

2.2. Sustainability Indicators Quantification Method

AHP, besides the decision problem structuring step, includes a technique to weight the proposed alternatives, based on the pairwise comparison of the importance of the included criteria [47–50]. This was used in the proposed method to evaluate and quantify the formed sustainability indicators as alternatives. According to the AHP, verbal comparison judgments are transformed into numerical quantities on a 1 to 9 scale (1 for equal importance judgements to 9 for absolutely more important judgements). In a similar approach, political, economic, social, technical, environmental and legal issues of Cyprus' hydrocarbon sector could be pairwise compared as follows:

Political vs. Economic
Political vs. Social
Political vs. Technical
Political vs. Environmental
Political vs. Legal
Technical vs. Environmental
Technical vs. Legal
Legal vs. Environmental
Economic vs. Social
Economic vs. Technical
Economic vs. Environmental
Economic vs. Legal
Social vs. Technical
Social vs. Environmental
Social vs. Legal

These comparisons are ranked and quantified by using the following judgement choices:

- First issues are of absolutely higher importance;
- First issues are of very strongly or demonstrably higher importance
- First issues are of strongly higher importance
- First issues are of higher importance
- The compared issues are of equal importance
- Latter issues are of higher importance
- Latter issues are of strongly higher importance
- Latter issues are of very strongly or demonstrably higher importance
- Latter issues are of absolutely higher importance

An evaluator can be called to pairwise compare political, economic, social, technical, environmental and legal issues by selecting one of the above judgement choices for each pair of issues. Therefore according to the evaluators judgements for each pair, the weight of a quantity for each issue, i.e., the indicator, can be calculated following the AHP criteria weighting technique [47,48]. The inconsistency-checking step included in the method aids in detecting judgements that should be corrected in order to yield consistent results. Furthermore, strengths are positives and weaknesses are negatives related to internal factors. Opportunities are external factors having a positive interaction and threats represent the negative effects on the system environment [38]. Consequently, values of indicators expressing the strengths and opportunities take a positive sign while values of indicators expressing weaknesses and threats are negatives. Hence, according to the choices and their classification, the related indicators are quantified and evaluated, showing the importance of each issue and enabling observers to draw conclusions.

2.3. Evaluations Collection Method

The AHP theory of measurement through pairwise comparisons relies on expert judgements to derive the priorities [50]. In order to ensure the results objectivity, the problem evaluation should be

based on the judgements of a team composed of different experts. These evaluators will pairwise compare the importance of the PESTEL issues in the hydrocarbon sector in Cyprus. The evaluation team synthesis should include the interested parties of Cyprus' hydrocarbon development and at the same time should consider all sustainability dimensions. In order to enable convenience and uniformity, a structured multiple-choice questionnaire was used for answers collection.

3. Results

3.1. PESTEL Analysis

Cyprus' hydrocarbon sector is currently under development and the situation is changing due to the detection of natural gas reserves. The following analysis includes issues and facts that either influence the sector or are inherent. The data were collected and gleaned from secondary data, as academic literature, government or international organizations websites, factsheets, reports, etc.

Political issues influence Cyprus' hydrocarbon development since Cyprus joined the European Union in May 2004, and therefore is committed to European policies and legislative framework as well as to the Europe 2020 targets [51]. Moreover, there is a particular situation known as the Cyprus Problem, Cyprus dispute or Cyprus conflict. After the military Turkish invasion in 1974, the country was divided into two main parts, the southern part which is under the control of the recognized Republic of Cyprus government, and the northern part which is under Turkish occupation [52].

The economic context includes economy growth after a recession period. In fact, the gross domestic product (GDP) growth rate for the second quarter of 2018 was +3.9% compared to the same quarter of 2017 [53]. Moreover, Cyprus has been a Eurozone member since 2008. This membership offers advantages and benefits to its economy such as improved economic stability and growth, greater security and more opportunities for businesses and markets [54]. Other related facts which should be noted are that natural gas consumption has a significant and positive impact on economic growth in the long run [55], and that it is anticipated that electricity generation fuel shift from heavy fuel oil to natural gas for power generation will lead to a lower generation cost for the country [39]. Furthermore, the development, exploitation size and speed of the deep water oil and gas discoveries depend on sustainable contemporary international oil price levels [56].

In relation to the social issues that influence the hydrocarbon sector, the Human Resources Development Authority of Cyprus forecasts that the electricity supply and natural gas sector will have new employment needs for the next years, i.e., from 1930 positions in 2017 to 2079 in 2027 [57]. On the other hand, oil and gas extraction activities meet social resistance [58] and they have a high occupational health and safety risk as they are connected to high rates of injuries and fatalities [59].

Regarding the technical context, the energy demand in Cyprus is projected to rise, calculated to be 5% to 44% higher in 2040 than that it was in 2010 [41]. Furthermore, there is planning for energy interconnections such as the "EastMed Pipeline", aiming to link the East Mediterranean gas reserves to the Greek mainland via Crete, which has been labelled as a Project of Common Interest (PCI) by the European Union [60].

Concerning the environmental issues, it could be noted that natural gas has environmental benefits. It is considered to be a more environmentally friendly clean fuel than other fossil fuels such as coal and crude oil [61]. Due to the relatively low emissions of carbon dioxide and local air pollutants, it is a promising transition energy source between higher-carbon fossil fuels and renewable energy sources [62]. On the other hand offshore oil and gas activities are associated with many potential impacts to the environment [56,63].

The legal framework is dominated by solid Cypriot and European legislation, which regulates all key issues of hydrocarbon prospection, exploration and exploitation, such as licensing, health and safety as well as environment protection issues.

3.2. SWOT Sustainability Indicators

The above PESTEL analysis shows the strengths, weaknesses, and opportunities of Cyprus' Hydrocarbon sector, which are settled as sustainability indicators. These indicators are presented and classified in the SWOT matrix in Table 1.

Table 1. Cyprus Hydrocarbons sector sustainability indicators SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix.

Indicators	Strengths	Weaknesses	Opportunities	Threats
Political			P1. EU membership	P2. Cyprus problem
Economic	E1. Natural Gas price		E2. Cyprus GDP growth	
Social	S1. Sector employment needs	S2. H & S risks		S3. Social acceptance
Technical	T1. Interconnection pipeline		T2. Energy demand rise	
Environmental	EN1. Natural Gas environmental benefits as fossil fuel	EN2. Natural Gas extraction environmental impacts		
Legal	L1. Legislative context			

3.3. Pairwise Comparisons

Cyprus' hydrocarbon sector is still at the embryonic stage with an unusually complex microenvironment, a unique macro-environment and a large number of gestating public and private actors [64]. Decision making requires knowledge of the problem, the need and purpose, the criteria and sub-criteria, the affected stakeholders and groups and the alternative actions to carry out [50]. In order to satisfy these four conditions, experts with different backgrounds were called to pairwise compare the importance of the six elements of the PESTEL analysis through a structured questionnaire. These were a hydrocarbon expert, who is a marine engineer working for a company supporting exploration activities, an economy expert, who works in the accounting services sector, an environment expert who is an environment scientist and consultant and an environmentalist who is active member of the environment interested civil society. The array of the chosen specialties aimed to cover all three sustainability pillars, i.e., society, economy and environment, as well as the interested parties of the hydrocarbon development process. Different specializations and points of view are expected to guide to diverse comparisons and to generate the most possible complete result.

The collected judgements, per choice, are presented in Figure 4 and Table 2. The answers summary review shows that there is a diversity of opinions. Although trends to one or other direction for some pairs are observed, e.g., economic issues vs. technical or political issues, environmental vs. technical or social, more comparisons include at least one judgement of equality or of the opposite view. For the cases of economic vs. environmental or social issues, there was a completely divided view from the evaluators, i.e., two of them choose one side and the other two promoted the other side. The only shared belief is that environmental issues are of higher importance compared to political issues. It is obviously concluded that Cyprus' hydrocarbon sector assessment is not an object of common perception and there is agreement between the several parts involved.

3.4. Indicators Quantification

For group decision-making, judgements must be combined so that the reciprocal of the synthesized judgements are equal to the syntheses of the reciprocals of these judgements. Therefore, the geometric mean of the hierarchies calculated should be used as the final collective hierarchy [50]. Hence, the four experts' answers were individually processed in order to quantify the indicators according to each opinion. Using this process, the final indicators values were calculated as defined above.

Quantifications were processed by using the free web based AHP Calculator, AHP Online System–BPMSG (Business Performance Management Singapore) [65]. The twelve (12) indicators were input as criterions and sixty-six pairwise comparisons were processed for each expert case. The expressed judgement relationships of the six issues, i.e., political, economic, social, technical, environmental or legal were used and the indicators concerning the same issues were judged as of equal importance. After the necessary consistency ratio improvement, in order to be under 10%, the priority percentage hence weight, i.e., value of each indicator, was calculated. The results and the indicators' rank, as were exported by the calculator for each expert responses, are presented in Table 3.

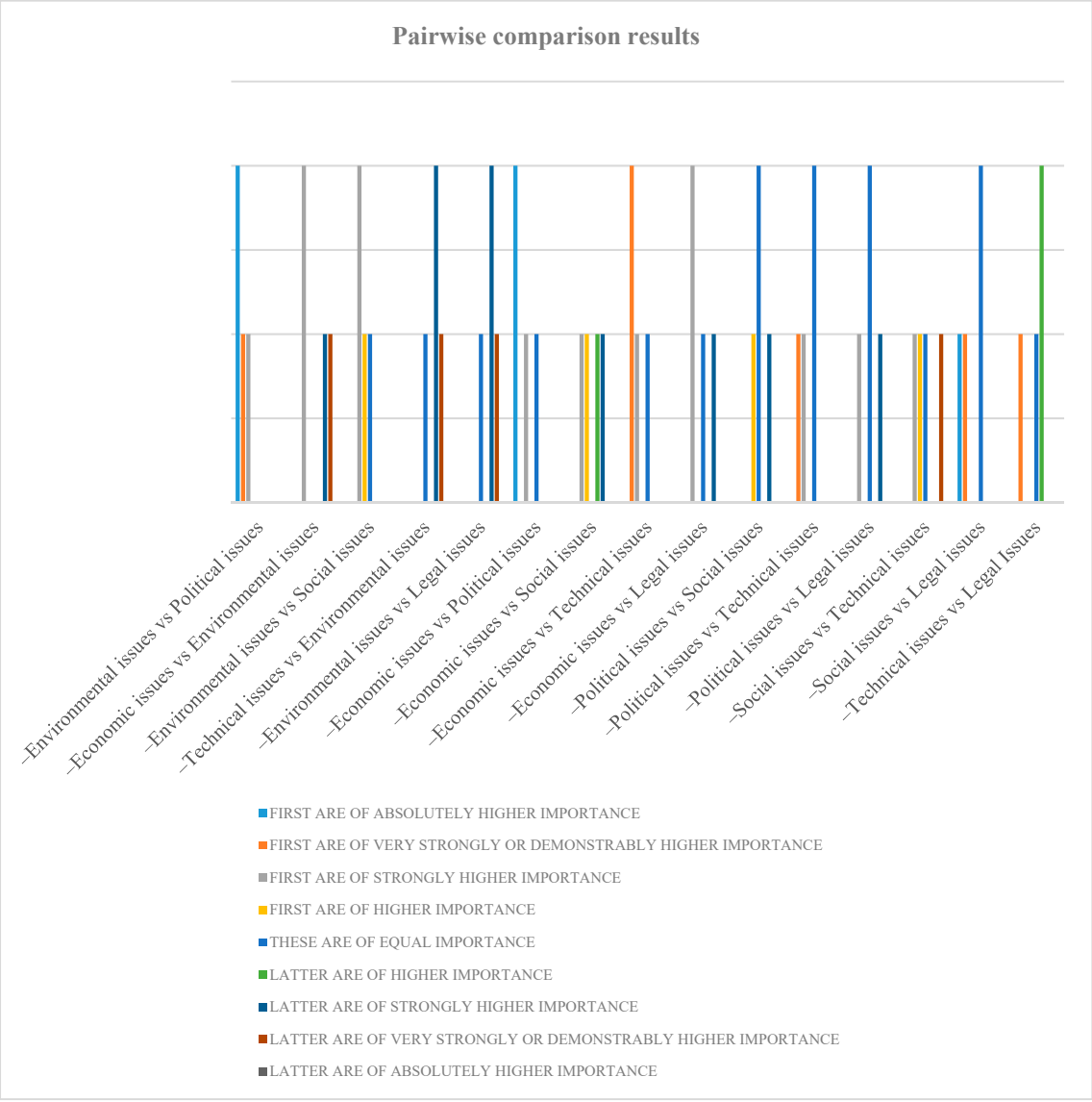

Figure 4. Pairwise comparisons.

Table 2. Collected judgements.

PAIRWISE COMPARISONS	FIRST ARE OF ABSOLUTELY HIGHER IMPORTANCE	FIRST ARE OF VERY STRONGLY OR DEMONSTRABLY HIGHER IMPORTANCE	FIRST ARE OF STRONGLY HIGHER IMPORTANCE	FIRST ARE OF HIGHER IMPORTANCE	THESE ARE OF EQUAL IMPORTANCE	LATTER ARE OF HIGHER IMPORTANCE	LATTER ARE OF STRONGLY HIGHER IMPORTANCE	LATTER ARE OF VERY STRONGLY OR DEMONSTRABLY HIGHER IMPORTANCE	LATTER ARE OF ABSOLUTELY HIGHER IMPORTANCE
Environmental issues vs. Political issues	2	1	1	0	0	0	0	0	0
Economic issues vs. Environmental issues	0	0	2	0	0	0	1	1	0
Environmental issues vs. Social issues	0	0	2	1	1	0	0	0	0
Technical issues vs. Environmental issues	0	0	0	0	1	0	2	1	0
Environmental issues vs. Legal issues	0	0	0	0	1	0	2	1	0
Economic issues vs. Political issues	2	0	1	0	1	0	0	0	0
Economic issues vs. Social issues	0	0	1	1	0	1	1	0	0
Economic issues vs. Technical issues	0	2	1	0	1	0	0	0	0
Economic issues vs. Legal issues	0	0	2	0	1	0	1	0	0
Political issues vs. Social issues	0	0	0	1	2	0	1	0	0
Political issues vs. Technical issues	0	1	1	0	2	0	0	0	0
Political issues vs. Legal issues	0	0	1	0	2	0	1	0	0
Social issues vs. Technical issues	0	0	1	1	1	0	0	1	0
Social issues vs. Legal issues	1	1	0	0	2	0	0	0	0

Table 3. Indicators quantification and rank for each expert (AHP (Analytical Hierarchy Process) Online System –BPMSG (Business Performance Management Singapore) results).

EVALUATOR	ECONOMY EXPERT		ENVIRONMENTALIST		HYDROCARBONS EXPERT		ENVIRONMENT EXPERT	
NUMBER OF COMPARISONS	**66**		**66**		**66**		**66**	
CONSISTENCY RATIO (CR):	**9.2%**		**9.7%**		**8.1%**		**9.8%**	
INDICATOR	**Priority (%)**	**Rank**	**Priority (%)**	**Rank**	**Priority (%)**	**Rank**	**Priority (%)**	**Rank**
P1. EU MEMBERSHIP	2.6	12	5.8	7	3.4	9	4.9	7
P2. CYPRUS PROBLEM	3.4	11	5.8	7	3.3	10	4.9	7
E1. NATURAL GAS PRICE	15.4	1	8.3	3	14.3	4	5.5	5
E2. CYPRUS GDP GROWTH	15.4	1	8.3	3	14.8	3	5.5	5
S1. SECTOR EMPLOYMENT NEEDS	9.2	3	6.1	5	5.3	6	2.4	10
S3. SOCIAL ACCEPTANCE	9.2	3	4.9	10	6.5	5	2.5	9
T1. INTERCONNECTION PIPELINE	7.4	6	3.0	11	4.0	8	8.5	3
T2. ENERGY DEMAND RISE	7.4	6	3.0	11	2.2	11	7.1	4
EN1. NATURAL GAS ENVIRONMENTAL BENEFITS AS FOSSIL FUEL	7.4	8	21.5	1	18.9	2	25.8	2
EN2. NATURAL GAS EXTRACTION ENVIRONMENTAL IMPACTS	7.4	8	21.5	1	20.4	1	28.9	1
L1. LEGISLATIVE CONTEXT	6.3	10	5.7	9	1.7	12	1.7	12

The geometric means of the calculated values are presented in Table 4. The indicators, classified as strengths and opportunities, are positive and the ones as weaknesses and threats, are negative. Therefore, in order to take their final value, they take the corresponding sign as indicated in Table 4. The indicators size as well as their rank are pictured in Figure 5. The total negative vs. the total positive area, the indicators cover, are presented in Figure 6, respectively.

Table 4. Indicator values.

Indicator	Geometric Mean (%)	+/−	Value (%)
EN2. NG extraction environmental impacts	17.50	−	−17.50
EN1. NG environmental benefits as fossil fuel	16.69	+	16.69
E2. Cyprus GDP growth	10.10	+	10.10
E1. NG price	10.01	+	10.01
T1. Interconnection pipeline	5.24	+	5.24
S3. Social acceptance	5.20	−	−5.20
S1. Sector employment needs	5.17	+	5.17
S2. H & S risks	5.17	−	−5.17
T2. Energy demand rise	4.32	+	4.32
P2. Cyprus problem	4.23	−	−4.23
P1. EU membership	3.98	+	3.98
L1. Legislative context	3.19	+	3.19

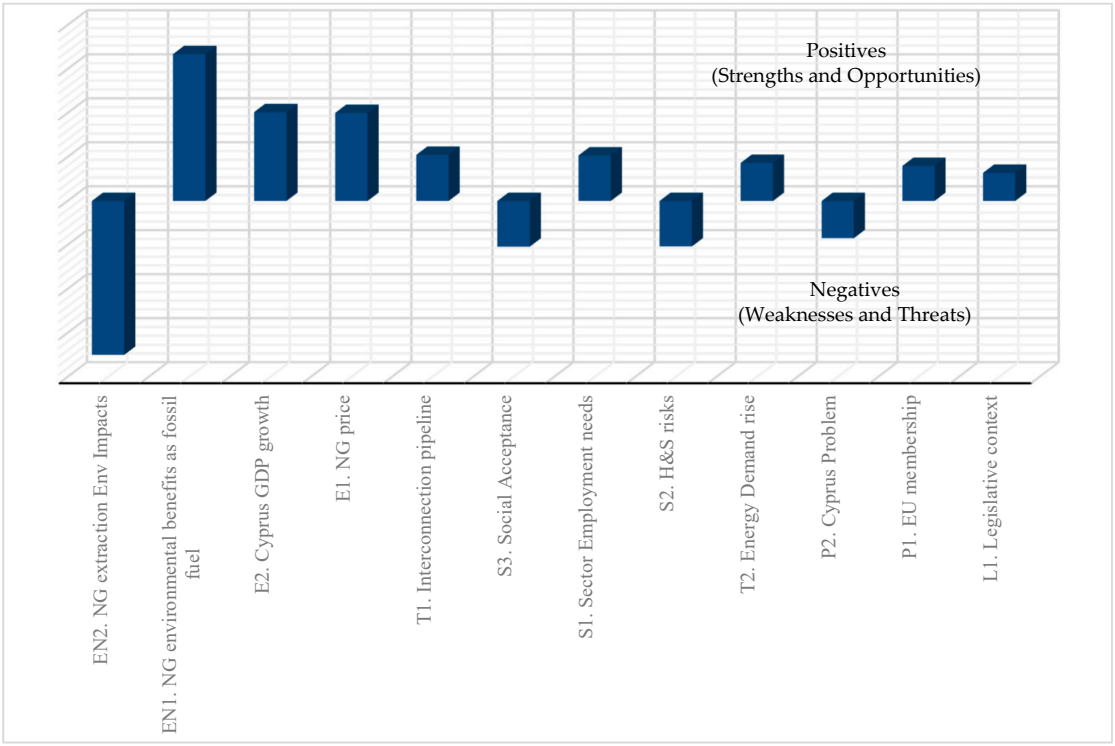

Figure 5. Indicator values size.

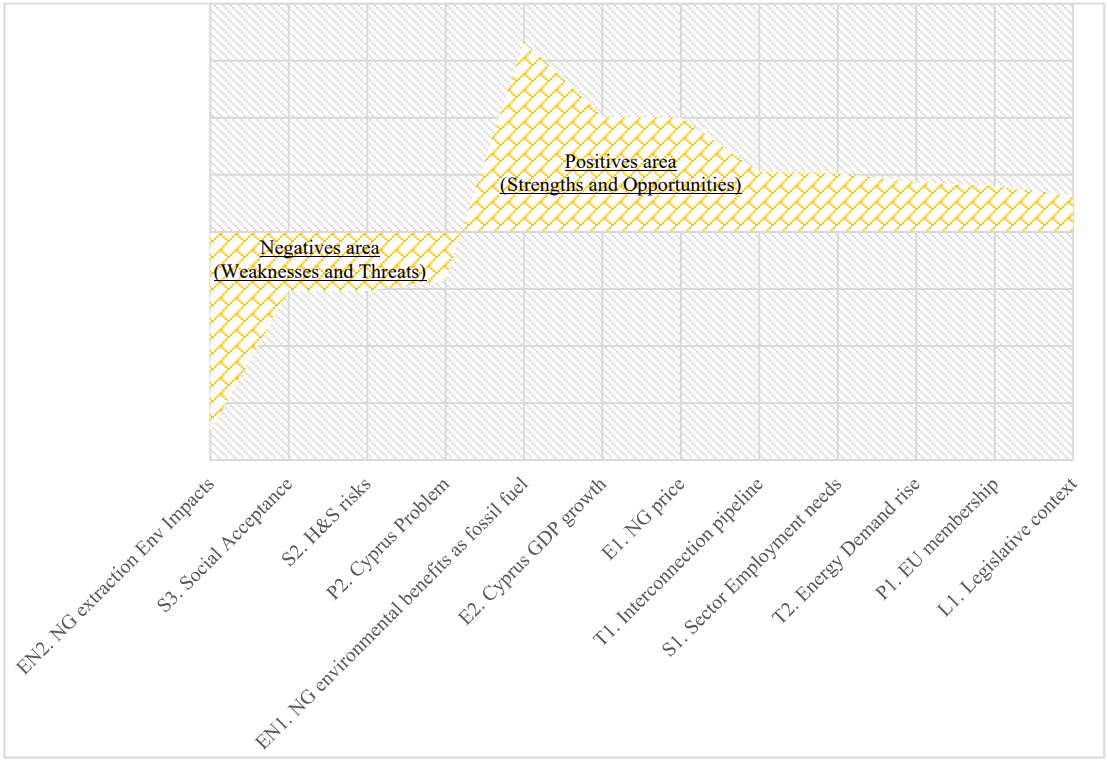

Figure 6. Positive indicators area vs. negative indicators area.

4. Discussion

According to the above results, the primary qualitative analysis emerges that Cyprus' hydrocarbon sector could be sustainable. In the framework of the formed indicators evaluation, it obviously presents more positives than negatives. The quantification process verifies this result also. Detected sector strengths and opportunities are more than the weaknesses and threats, and the total area they occupy, as presented in Figure 6, is more extensive.

The environmental issues importance is in all comparisons was greater than any other issue, except the legal ones. Furthermore, all experts' judgements, except the economy expert's ones, emerged as of the highest value. Therefore, the protection of the environment is highly evaluated and the relevant matters should be treated by priority. The two relevant indicators are calculated to have the first and second highest values. So they are ranked accordingly. Moreover, it must be noted that EN1 (natural gas environmental benefits as fossil fuel) is a strength with a positive value and EN2 (natural gas extraction environmental impacts) is a weakness with a negative value. Hence, these two indicators distribute their importance and value between the positive and the negative areas. This demonstrates that the environmental issues of the hydrocarbons sector have both constructive and contrary effects.

The third and fourth ranking positions are allocated to the two economic indicators. E1 (natural gas price) is a strength and E2 (Cyprus GDP growth) is an opportunity. So both add their value to the positive area. Therefore, hydrocarbons' economic aspect is considered to be of high importance and it positively affects sector development. So it should be handled accordingly. However, it is notable that only the economy expert evaluated them as of the highest value. The others' judgements, ranked them between the third and fifth highest value.

The political and legal issues of the sector are evaluated as of the lowest importance. The relevant experts' opinions resulted in generally low, but diverse ranking positions. The indicators P1 (EU membership) and L1 (legislative context) were expressed as an opportunity for the former and as a strength the latter, so they affect positively the sector development. P3 (Cyprus problem) is a threat with a negative impact. Their collective input into the positives area is not significant. Nevertheless,

they add to the total result and their low values indicate that they should be treated. However, it must be ensured that the consequent decisions will not delay the development of the hydrocarbon sector.

The middle values and ranking positions are occupied by technical and social issues. Both technical indicators are positive. They should be used accordingly. However, it must be noted that T1 (interconnection pipeline) which is a strength has a significantly higher value than T2 (energy demand rise) which is an opportunity and this should be considered. The ranking positions between them are occupied by the three social indicators. The threat S3 (social acceptance) had the highest value, and strength S1 (sector employment needs) had the second, and the weakness S2 (health and safety risks) were the lowest among them. However, it is obvious that the two of them contributed significantly to the negative area. If they will not be efficiently treated, they could be a strong burden for the sectors sustainability. Another observation regarding these issues is that the experts' evaluations for them were not in consonance.

The above results features the positives that need to be either improved or exploited and the negatives that need to be mitigated or eliminated. In this framework, in order to develop the Cyprus hydrocarbon sector in a sustainable way, the following recommendations for decision-making and policy formulation were extracted. Hydrocarbon development in Cyprus should proceed by ensuring the protection of the environment. Environmental impacts of the activities may be multiple [56,63] and are evaluated by the experts as significant, so they should be eliminated. The same should be done for the health and safety risks, which could also be severe [59], although they have a medium value. Furthermore, since renewable energy projects could be effectively developed on the island [2], their promotion instead of fossil fuel extraction should be seriously considered. Economic issues such as natural gas price, Cyprus' economic growth and their contribution to a positive result should also be considered in the process. The first should be monitored and be a key decision factor, as it plays a significant role in the speed and extent of the development [56]. The second could ensure the needed financial sources for the undertaking in the long term.

Social acceptance is also important and needs to be established. Opposition from local communities is connected to the environmental issues [58], so ensuring protection of the environment will contribute to mitigate any rejections or protests. The advantage of the sectors potential employment needs must be exploited as well as Cyprus' EU membership. This could ensure the elimination of civil war, autocracy, lack of economic development and terrorism, connected to fossil fuel production [8,9]. Cyprus' political problem, which is a significant issue for the island, may not have been comparatively evaluated or of major importance, but as it is a threat for the sustainability of the process, it must be suitably managed. Besides, hydrocarbon development could potentially enable a Cyprus problem settlement [66]. Furthermore, the technical aspects of the process could be exploited more intensely. Prospected country energy demand rise [41] could create local interest and need. Moreover, the planned pipeline interconnections [60] could provide overseas sale options for the available natural gas.

MCDM techniques can be used to support sustainable decision-making for energy issue solving and to evaluate contradictory effects [25]. Furthermore, their use with SWOT [35–37] and SWOT-PESTEL [38] has proved effective for analysis. Moreover, the PESTEL-SWOT combination is able to guide results and conclusions. The method applied in this paper presents the successive application of the three tools for sustainability assessment and planning for energy issues. The results of PESTEL fed the SWOT analysis. Afterwards, AHP was used to quantify and evaluate the SWOT output. The Cyprus hydrocarbon sector evaluation results show that this method can be implemented and export useful outcomes.

5. Conclusions

The proposed methodology provides a suitable tool, able to analyze both external and internal issues, to consider multiple interested parties' opinions and to extract quantified results. The importance of the derived results is that they contribute to general conclusions and recommendations; they also give values to individual sustainability indicators. Therefore, a decision

maker is able to know the specific matters and situations that should be treated and the appropriate timeframe and intensity of handling. Moreover, despite the diverse experts' judgements and evaluations for the issues and the indicators, a composed outcome is extracted. This could aid to an agreement, between the stakeholders, for the necessary policies and actions.

The interpretation of the results of the evaluation of the PESTEL-SWOT formed sustainability indicators leads to the general observation that the hydrocarbon sector in Cyprus could be sustainably developed. In order to reach this sustainability, it's political, economic, social, technical, environmental and legislative negative aspects, that have been detected and evaluated, should be mitigated or eliminated and the respective positive ones should be enhanced and exploited. The present works' observations could be quite useful for decision makers to form relevant decisions and choices in order to incorporate them into a strategic planning framework. Other East Mediterranean countries, like Israel [67] and Egypt [63] have natural gas reserves also. So the proposed methodology could be considered for their energy planning as well.

Although the PESTEL issues pairwise comparison facilitated the judgements' selection by the experts, and the calculations and opinions collected were extended to the relevant indicators, it should be noted that the results could be more representative, if the comparisons were performed for each indicator to all others. This would be more demanding to process, but the detailing could guide to more accurate and extensive conclusions.

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