



EVALUATION OF NATURAL GAS STRATEGIES OF TURKEY IN EAST MEDITERRANEAN REGION: A STRENGTHS-WEAKNESSES-OPPORTUNITIES-THREATS AND ANALYTIC NETWORK PROCESS APPROACH

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Abstract. Demand for natural gas has severely challenged the world supply among other types of energy sources such as coal, geothermal, nuclear and etc. Natural gas is the most important form of energy because it is clean, abundant, reliable and versatile. Due to the limited and transportable characterizes of natural gas, sharing pipelines for natural gas with other nations can either bring peace and stability or create chaos. To avoid insoluble strategies, it is very explicit to decide scientifically for these kinds of global issues. To do so, a SWOT (Strengths, Weaknesses, Opportunities and Threats) – ANP (Analytic Network Process) integrated approach is presented to evaluate natural gas policies for Turkey in terms of East Mediterranean Region. In the first step, the appropriate strategies, SO (strengths-opportunities), ST (strengths-threats), WO (weaknesses-opportunities) and WT (weaknesses-threats) are determined via SWOT analysis including four criteria, 20 sub-criteria and seven strategies. Due to inability of SWOT analysis to prioritize the criteria and rank the strategies, ANP approach which also considers the dependency between criteria is applied in the second step. Finally, the proposed SWOT-ANP approach is compared with other multi criteria decision making (MCDM) techniques to represent the effectiveness and applicability of the model.

Keywords: natural gas, strategic policy, evaluation, ANP, SWOT.

JEL Classification: C63, D81, M00, P48.

Introduction

Energy affects the quality of our lives significantly. Nowadays, we are addicted to continuous supply of energy for living and working. It is a leading actor in all sectors of modern economies. Energy demand in the world is increasing rapidly. Demand for energy in the world increased from 8769 million tons of oil equivalent (Mtoe) in 1990 to 13240 Mtoe in 2012 (Table 1).

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Table 1. World primary energy demand by fuel (Mtoe) (WEO 2014)

Energy Demand	1990	2000	2012	2020	2025	2030	2035	2012–2035*
Oil	3231	3663	4158	4469	4545	4600	4666	0.5%
Gas	1668	2072	2869	3234	3537	3824	4127	1.6%
Coal	2230	2357	3796	4137	4238	4309	4398	0.6%
Nuclear	526	676	642	869	969	1051	1118	2.4%
Hydropower	184	225	313	391	430	466	501	2.1%
Biomass and Waste	893	1016	1318	1488	1598	1718	1848	1.5%
Other Renewables	36	60	142	311	432	566	717	7.3%
Total (Mtoe)	8769	10070	13240	14899	15749	16534	17376	1.2%

Note: * Average annual growth rate.

Countries which are close to the East Mediterranean Region including Cyprus, Greece, Lebanon, Syria, Israel, State of Palestine, Turkey, Egypt, Jordan, and Libya and some countries from Europe (Italy, Albania and etc.) will inevitably be affected from stability or instability of the region. It is the fact that energy transportation is as important as having energy sources. Sharing energy sources can either bring peace and stability or create chaos for the region. To achieve a sustainable energy policy, countries in this region and neighboring countries should implement peaceful strategies for energy. Natural gas is the most important form of energy because it is clean, abundant, reliable and versatile. In recent years, gas supply has rose when compared to other energy sources in the region. Figure 1 shows the total primary energy supply in East Mediterranean Region, and gas energy is increasing from 46% to 54% from 2009 to 2020. The gas inevitably will be transferred from East Mediterranean Region to Europe, which is one of the biggest energy markets. The total magnitude of natural gas resources in the East Mediterranean is difficult to assess. The U.S. Geological Survey has estimated resources in the region at 3,500 billion cubic meters (bcm). This could guarantee gas supplies for the region for 50–100 years. However these estimates are not confirmed and it is not yet clear if the production of these quantities from great depths at sea will always be economically viable (Koehler 2012). Still The Eastern Mediterranean catchment basin has emerged as a natural gas producing region recently. Spurred by discoveries and production offshore of Egypt and Israel, exploration has intensified in the basin, and additional natural gas and oil discoveries are likely during the current decade (Shaffer 2012). The Eastern Mediterranean region contains eight significant basins for gas sources (Cyprus Basin, Eratosthenes High, Latakia Basin, Levant Basin, Judea Basin, Nile Delta Basin, Western Arabian province and Zagros province). As shown in Figure 2, Levant Basin has high importance and capacity. In the region, important natural gas fields that were discovered in the past decade that belongs to the Levant Basin. They are mostly in Israel's territorial waters, but there are some significant discoveries in Cyprus and the Palestinian Territories too (AEO 2013).

Currently, the new discoveries of Israel and Cyprus won't be a game changer for European and Asian markets. However, if some additional volumes are discovered then authorization is given for export, European Union and third-country markets may also benefit. In any

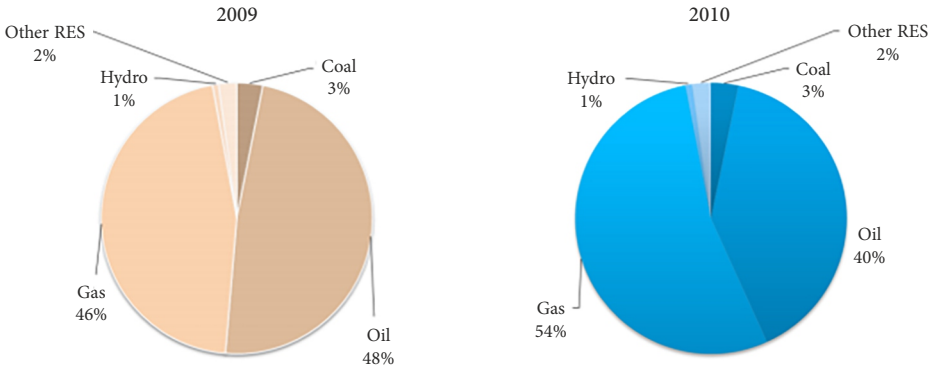


Fig. 1. Total primary energy supply in East Mediterranean Region (OME 2011)



Fig. 2. Levant Basin in East Mediterranean Region (AEO 2013)

case, the new discoveries are important for the region and it will change the usage of energy (Shaffer 2012). The increasing importance of the region will effect political situation due to sharing of sources. The conflicts and disputes in a region are forcing the countries to implement suitable strategic energy policies based on scientific methods. If the strategic decisions do not have scientific basis, they may change according to people who are in charge of a country. Also energy policies have different instruments to attach. The context is related not

only with the energy supply/demand, but also political, environmental, administrative, legal and market issues. The concern about security and external source safety is also a major issue. Strategies should be developed by considering every detail. Governmental and public concern has focused on the risks associated with dependence on external sources, political uncertainty in external supplier and transit states, and the potential for disruptions to energy supplies (ECA 2015). The security of energy is gaining extra importance when we focus on the Eastern Mediterranean Region. For that reason, we will formulate the strategies considering all the possible effects.

Significant amount of researches have been proposed to find suitable solutions or strategies for energy policies in recent years. For those strategies, researchers need applicable mathematical approaches and convenient specialist remarks because increasing complexity of energy supply and traditional form of planning processes would make it difficult for the decision makers to decide in appropriate ways. In the analysis process, to determine the definition of problem and to formulate the strategy for the solutions is a requisite determinant. SWOT analysis is important for systematic analysis of both internal / external factors thus becoming an important decision making tool. It is a useful model for any systems that try to identify strengths, weaknesses, opportunities and threats. By doing so, SWOT analysis tries to analyze the internal situation and external conditions; as a result decision makers design their strategies accordingly (Chaghooshi *et al.* 2011). SWOT analysis mainly deals with strategic planning process however its area of interest is not limited with it. Strategic planners and academicians use SWOT analysis in various fields, such as strategies for enterprises (Houben *et al.* 1999; Chang, Huang 2006; Yüksel, Dağdeviren 2007; Hashemi *et al.* 2011; Jeyaraj *et al.* 2012), city planning (Vanek *et al.* 2012), regional planning (Karppi *et al.* 2001), health care (Harrison 2010). To get the full advantage of SWOT, it is important to use the tool correctly. The analysis should provide decision makers with related information to make the strategic decisions. It means that, the lists of strengths, weaknesses, opportunities and threats are not helpful themselves. It helps when the potential implications of this information for the organization are conducted that the planners can get significant analysis (Chang, Huang 2006). Even applied properly, SWOT analysis does not provide an analytical means to determine the importance of the identified factors or the ability to assess decision alternatives according to these factors (Yüksel, Dağdeviren 2007).

After formulating the strategies for the strategic planning process, literature presents various mathematical approaches to find a solution for the decision makers. The Analytic Network Process seems one of the featured methods among them. Considering all the disputes, the sustainable energy strategies are vital for the countries in the region and neighboring countries. To advise a scientific strategy for Turkey, a hybrid MCDM approach for reasonable decisions is proposed in this paper. To do so, a SWOT-ANP integrated approach is presented to evaluate natural gas policies for the East Mediterranean Region in this study. In the first step, the appropriate strategies, SO (strengths-opportunities), ST (strengths-threats), WO (weaknesses-opportunities) and WT (weaknesses-threats) are determined via SWOT analysis including four criteria, 20 sub-criteria and seven strategies. Due to inability of SWOT analysis to prioritize the criteria and rank the strategies, ANP approach which also considers the dependency between criteria is applied in the second step. Finally, the proposed SWOT-ANP

approach is compared with other MCDM techniques to represent the effectiveness and applicability of the model.

Our paper is formed as follows; the related literature including SWOT and ANP methods will be explained in Section 2. SWOT analysis, ANP approach and proposed model which combines SWOT and ANP methodologies will be presented briefly in Section 3. Application of proposed methodology to natural gas strategy problem will be provided in Section 4. In the last section, the findings will be discussed and conclusion will be stated.

1. Literature review

The researchers who integrate MCDM techniques and SWOT analysis are common in literature. SWOT method provides a frame related to the decision situation, but it is unable to rank neither the strategies nor the factors. But the dependency between factors affects the priority of strategies. Thus, the MCDM techniques assist in doing SWOT analysis more analytically and thoroughly so that those strategic decision alternatives can be prioritized. Therefore, Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP) are usually applied to examine whether the dependency among the factors changes the priorities of strategies (Yüksel, Dağdeviren 2007; Zheng, Liu 2013; Zhou, Chen 2014). Besides AHP and ANP approaches, VIKOR (Azimi *et al.* 2011b), DELPHI (Tavana *et al.* 2012) and TOPSIS (Arabzad *et al.* 2015) methods are also used within SWOT analysis in literature. The merits and demerits of various MCDM methods have been described in Table 2.

Azimi *et al.* (2011a, 2011b) surveyed the Iranian mining sector with different methodologies and from different points of view in two studies. They prioritized the strategies and alternatives by TOPSIS and VIKOR in addition to SWOT analysis. Babaesmailli *et al.* (2012) examined a tile manufacturing firm as a case and described the dependency among factors and sub-factors effecting the decisions. Sevkli *et al.* (2012) examined the strategic management of an airline industry in Turkey while Tavana *et al.* (2012) examined the strategies of an Oil Company focusing on Caspian Sea basin. Zhou and Chen (2014) prioritized strategies for grassland management in China. As recent studies; Lee (2015) surveyed location selection for secondhand tier city in China, Groselj and Stirn (2015) and Reinsberger *et al.* (2015) examined environmental management problems for Slovenia and Austria.

To improve the efficiency of SWOT analysis, some extensions have been applied to SWOT in recent years. A'WOT method that is one of them is an integrated method of AHP with SWOT analysis (Kajanus *et al.* 2004). The aim of applying the hybrid method is to improve the quantitative basis of strategic planning processes. After applying the A'WOT method, decision-makers have information at their disposal about how alternative strategies are congruent with internal and external factors. Since MCDM problems and techniques are very common in literature, we will focus only on the techniques which are used together by SWOT. The proposed technique in this paper is SWOT-ANP and as can be seen below, Table 3 gives a summary of the researches practically and briefly about this technique. As it is seen from Table 3, SWOT-ANP technique is used in prioritizing alternatives of strategic decisions. But, to the best of our knowledge, it has not been used in energy strategy decision making in literature yet. Thus the paper mainly focuses on SWOT-ANP analysis about natural gas strategies of Turkey.

Table 2. MCDM methods with its merits and demerits (Aruldooss et al. 2013; Gavade 2014)

Methods	Description	Advantages	Disadvantages
AHP	It builds the decision problem from arrangement of different goals, criteria and alternatives and pair wise comparison of the criteria to obtain the best alternative.	(i) Flexible, intuitive and checks inconsistencies; (ii) Since problem is constructed into a hierarchical structure, the importance of each element becomes clear; (iii) No bias in decision making.	(i) Irregularities in ranking; (ii) Additive aggregation is used. So important information may be lost; (iii) More number of pair wise comparisons are needed.
ANP	It is a generalization of the AHP, by considering the dependence between the elements of the hierarchy. Therefore, It is represented by a network, rather than a hierarchy.	(i) Independence among elements is not required; (ii) Prediction is accurate because priorities are improved by feedback.	(i) Time consuming; (ii) Uncertainty – not supported; (iii) Hard to convince decision making.
TOPSIS	It is a method of compensatory aggregation that compares a set of alternatives by identifying weights for each criterion, normalizing scores for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion.	(i) Easy decision making using both negative and positive criteria; (ii) Number of criteria can be applied during the decision process; (iii) Simpler and faster than AHP and ANP.	(i) Operation of normalized decision matrix in which the normalized scale for each criterion is usually derived a narrow gap among the performed measures.
VIKOR	It was developed to solve MCDM problems with conflicting and non-commensurable (different units) criteria, assuming that compromising is acceptable for conflict resolution, the decision maker wants a solution that is the closest to the ideal, and the alternatives are evaluated according to all established criteria.	(i) Proposing a compromise solution with an advantage rate; (ii) avoiding the pair-wise comparisons.	(i) The performance rating is quantified as crisp values.
ELECTRE	It is used to select the best choice with maximum advantage and least conflict in the function of various criteria.	(i) Outranking is used; (ii) Accepts qualitative and quantitative criteria.	(i) Time consuming; (ii) Difficult to understand because of the principles used in determining the concordance and discordance matrices.
PROMETHEE	It is an outranking method for a finite set of alternative actions to be ranked and selected among criteria, which are often conflicting.	(i) It can simultaneously deal with qualitative and quantitative criteria; (ii) Criteria scores can be expressed in their own units; (iii) It needs much less inputs.	(i) It suffers from the rank reversal problem when a new alternative is introduced; (ii) It does not provide the possibility to really structure a decision problem.

Table 3. MCDM techniques combined with SWOT in literature

Authors	Methods	Problem	Solution
Yüksel, Dağdeviren (2007)	SWOT, ANP	Evaluating of strategies for a textile company.	Criteria for determining the best strategy are prioritized by ANP.
Azimi <i>et al.</i> (2011a)	SWOT, ANP, TOPSIS	Ranking the strategies of mining sector in Iran.	ANP is applied in order to obtain the weight of SWOT factors, the strategies are ranked through TOPSIS.
Azimi <i>et al.</i> (2011b)	SWOT, VIKOR	Evaluating the strategies of the Iranian mining sector using an integrated model.	Six strategy alternatives are prioritized and ranked by VIKOR.
Babaesmailli <i>et al.</i> (2012)	SWOT, FUZZY ANP	Prioritizing strategies for tile manufacturing firm.	Dependency among factors and sub-factors, are shown by ANP.
Sevкли <i>et al.</i> (2012)	SWOT, FUZZY ANP	Determining the ranking of the factors in SWOT analysis for airline industry.	SWOT with fuzzy ANP methodology was implemented and tested for the Turkish airline industry for strategic management.
Tavana <i>et al.</i> (2012)	SWOT, DELPHI	Oil and gas pipeline strategic planning in Caspian Sea basin.	Horizon Oil Company is assisted in evaluating five export routes by Delphi.
Bas (2013)	SWOT, FUZZY TOPSIS, AHP	Analysis of electricity supply chain in Turkey.	SWOT with fuzzy TOPSIS methodology combined with AHP is proposed to prioritize the defined SWOT factors for formulating a strategy plan with priorities
Zheng, Liu (2013)	SWOT, ANP	Evaluating multifunctional agriculture in China.	The multi functionalities between rural areas are compared by ANP.
Tavana <i>et al.</i> (2013)	SWOT, DELPHI, PROMETHEE	Oil and gas pipeline planning in the Caspian Sea basin.	SWOT with Delphi method is used to capture the decision makers' beliefs. PROMETHEE is used to integrate these beliefs with subjective judgments.
Shahabi <i>et al.</i> (2014)	SWOT, ANP	Analysis and prioritizing the Iran's steel scrap industry strategies.	Dependency among factors and sub-factors, are shown by ANP.
Zhou, Chen (2014)	SWOT, AHP	Grassland management in China.	A strategy for grassland management is offered after prioritizing strategies by ANP.
Lee (2015)	SWOT, FUZZY ANP, GSM	Location selection for a second tier city in China.	Cities are selected as the best alternatives for second tier city locations by a hybrid technique.
Groselj, Stirn (2015)	SWOT, ANP	Environmental management problem of Pohorje, Slovenia.	Identification of the alternatives is done by AHP.
Reinsberger <i>et al.</i> (2015)	SWOT, AHP	Challenges related to photovoltaics in Austria about energy transition.	SWOT factors about energy transition are evaluated by AHP.
Arabzad <i>et al.</i> (2015)	SWOT, FUZZY TOPSIS	Supplier selection and order allocation problem.	Supplier selection criteria are determined by fuzzy TOPSIS from strategic point of view.

2. The proposed research framework

This section presents brief information on the SWOT analysis, followed by the same for the ANP approach. Finally, the proposed SWOT-ANP approach is given briefly.

2.1. Strengths-weaknesses-opportunities-threats analysis

SWOT analysis is commonly used as a way to analyze an organization's internal and external environments and this makes it an important support tool for decision making (Kangas *et al.* 2003). It is widely used for analyzing internal and external environments in order to attain a systematic understanding of a strategic management situation (Wheelen, Hunger 1995). It encourages strategists to bring up a strategy that can best fit with the situation. The philosophy of SWOT is that; the strategies of an organization should match the environmental threats / opportunities and with the organization's weaknesses and strengths. It tries to establish a strategic fit between an organization's internal strengths and weaknesses and the opportunities and threats posed by its external environment (Lu 2010). By identifying its strengths, weaknesses, opportunities, and threats, the countries can build strategies upon its strengths, eliminate its weaknesses, and exploit its opportunities or use them to counter the threats. Developing a SWOT matrix and identifying the elements contribute to see the main internal and external powers of the systems. Elaborate analysis of the above mentioned factors would put forth the strategies of the countries in any matter.

The SWOT matrix presents the linkage between the country's strengths and weaknesses (internal factors) and threats and opportunities (external factors) in the strategic planning. Thus it provides a framework for identifying strategies. The most challenging part of generating a SWOT matrix is matching the key internal and external factors. SWOT matrix helps decision makers to develop four types of strategies respectively as illustrated in Table 4, namely SO (strengths-opportunities) strategies, WO (weaknesses-opportunities) strategies, ST (strengths-threats) strategies and WT (weaknesses-threats) strategies.

SO strategies use a country's internal strengths to benefit from external opportunities. WO strategies try to take advantage of external opportunities and try to improve internal weaknesses. ST strategies use a country's strengths to avoid or reduce the impact of external threats. WT strategies try to reduce the internal weaknesses and avoid the environmental threats as a defending technique (Weihrich 1982). There are eight steps involved in constructing a SWOT matrix: (1) listing the key external opportunities, (2) listing the key external threats, (3) listing the key internal strengths, (4) listing the key internal weaknesses, (5) matching internal strengths with external opportunities and recording the resultant SO strategies, (6) matching internal weaknesses with external opportunities and recording the resultant WO strategies, (7) matching internal strengths with external threats and recording the resultant ST strategies and (8) matching internal weaknesses with external threats and recording the resultant WT strategies (David 2007).

Table 4. A generic presentation of the SWOT matrix (Sevkli *et al.* 2012)

Internal Factors	STRENGTHS-S		WEAKNESSES-W		
	1.	1.	1.	1.	
	2.	2.	2.	2.	
	. List of Strengths	. List of Weaknesses	. List of Weaknesses	. List of Weaknesses	
	
External Factors	N	N	N	N	
OPPORTUNITIES-O		SO STRATEGIES		WO STRATEGIES	
1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.
. List of Opportunities	. Use strengths to take advantage of opportunities	. Overcome weaknesses by taking advantage of opportunities	. Overcome weaknesses by taking advantage of opportunities	. Overcome weaknesses by taking advantage of opportunities	. Overcome weaknesses by taking advantage of opportunities
.
N	N	N	N	N	N
THREATS-T		ST STRATEGIES		WT STRATEGIES	
1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.
. List of Threats	. Use strengths to avoid threats	. Minimize weaknesses to avoid threats	. Minimize weaknesses to avoid threats	. Minimize weaknesses to avoid threats	. Minimize weaknesses to avoid threats
.
N	N	N	N	N	N

2.2. Analytic network process approach

Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in a hierarchy on lower-level elements. Not only does the importance of the criteria determine the importance of the alternatives as in a hierarchy, but also the importance of the alternatives themselves determines the importance of the criteria (Saaty, Vargas 2006). AHP is an approach which is suitable for dealing with complex systems related to making a choice from among several alternatives. It provides a comparison of the considered options. This method was first presented by Saaty in 1980. It is based on the subdivision of the problem in a hierarchical form. It helps to organize the critical aspects of a problem into a hierarchical structure similar to a family tree. By reducing complex decisions to a series of simple comparisons and rankings, then synthesizing the results, AHP helps the analysts to give the best decision, and also it provides a clear rationale for the choices to be made. The objective of using AHP is to identify the preferred alternative and also determine a ranking of the alternatives when all the decision criteria are considered simultaneously (Saaty 1980).

Saaty (1994) introduced ANP, a new generation of MCDM theory, to replace the AHP. The ANP method is a general theory of relative measurement used to derive composite priority ratio scales from individual ratio scales that represent relative measurements of the influence of elements that interact with respect to control criteria. As mentioned by Saaty (2005), ANP model consists of two main parts, that are a network of interrelationships among each two nodes or clusters and a control network of criteria or sub-criteria that controls interactions based on interdependencies and feedback. Here, nodes are indica-

tors of criteria for model construction, while clusters are groups of indicators for classifying criteria. In order to make a decision making process, a control hierarchy is generally employed to build an ANP model. The control hierarchy is a hierarchy of criteria and sub-criteria for which priorities are derived in the usual way with respect to the goal of a system being considered. The criteria are used to compare the clusters of an ANP model, while the sub-criteria are used to compare the nodes inside a cluster (Adam, Humphreys 2008). ANP approach that is based on the much stronger, absolute scales used to represent pairwise comparison judgments in the context of dominance with respect to a property shared by the homogeneous elements being compared (Saaty, Vargas 2006). The AHP allows for complex interrelationships among decision levels in a hierarchical structure (Saaty 1994). Many decision problems include interaction between criteria and alternatives or dependence of higher level elements in a hierarchy on lower level elements; therefore, they cannot be configured as a hierarchical decision problem. Although AHP allows a framework for uni-directional hierarchical relationships, the ANP is suitable for complex interrelationships among decision levels and alternatives (Saaty, Özdemir 2005). The AHP allows for complex interrelationships among decision levels and attributes (Saaty 1994). The ANP feedback approach replaces hierarchies (Fig. 3a) with networks (Fig. 3b) in which the relationships between levels cannot be easily represented as higher or lower, dominant or subordinate, direct or indirect (Saaty, Vargas 1998).

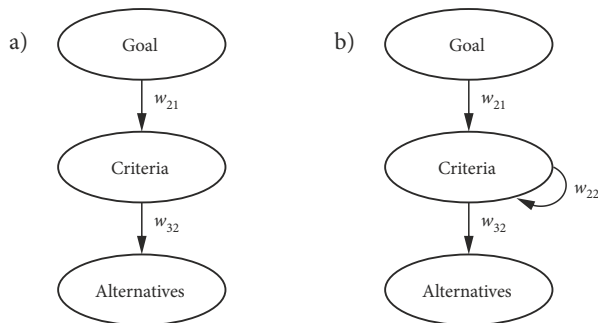


Fig. 3. Hierarchy and network: (a) hierarchy; (b) network (Yüksel, Dağdeviren 2007)

In ANP, the modelling process can be divided to three steps, that are described as follows:

Step 1: The Pairwise Comparisons and Relative Weight Estimation.

Before performing the pairwise comparisons, all criteria and clusters compared are linked to each other. The pairwise comparisons are made depending on the scale of ANP. In the pairwise comparison matrix, the score of a_{ij} represents the relative importance of the component on row (i) over the component on column (j). The reciprocal value of the expression ($1/a_{ij}$) is used when the component j is more important than the component i . The comparison matrix A is defined as:

$$A = \begin{bmatrix} w_1 / w_1 & w_1 / w_2 \cdots w_1 / w_n \\ w_2 / w_1 & w_2 / w_2 \cdots w_2 / w_n \\ \vdots & \vdots \quad \vdots \\ w_n / w_1 & w_n / w_2 \cdots w_n / w_n \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix}. \tag{1}$$

Then, a local priority vector (eigenvector) w is computed as an estimate of the relative importance accompanied by the elements being compared by solving the equation (2).

$$Aw = \lambda_{\max} w, \tag{2}$$

where λ_{\max} is the largest eigenvalue of matrix A .

Step 2: Formation of the Initial Supermatrix.

The Supermatrix representation of a network with three levels is given as follows (Fig. 3b):

$$W = \begin{matrix} & \begin{matrix} G & C & A \end{matrix} \\ \begin{matrix} \text{Goal (G)} \\ \text{Criteria (C)} \\ \text{Alternatives (A)} \end{matrix} & \begin{pmatrix} 0 & 0 & 0 \\ W_{21} & W_{22} & 0 \\ 0 & W_{32} & I \end{pmatrix} \end{matrix}. \tag{3}$$

W_{21} is a vector that represents the impact of the goal on the criteria, W_{22} is a vector that represents impact of the interdependences among criteria, W_{32} is also a vector that represents the impact of criteria on each of alternatives, and I is the identity matrix. Any zero value in the super-matrix can be replaced by a matrix if there is an interrelationship of elements within a cluster or between the clusters.

Step 3: Formation of the Weighted Supermatrix.

An eigenvector is obtained from the pairwise comparison matrix of the row clusters with respect to the column cluster, which in turn yields an eigenvector for each column cluster. The first entry of the respective eigenvector for each column cluster is multiplied by all the elements in the first cluster of that column, the second by all the elements in the second cluster of that column and so on. In this way, the cluster in each column of the supermatrix is weighted, and the result, known as the weighted supermatrix is stochastic.

2.3. Proposed model

Purpose of model is to identify Turkey’s natural gas policies and evaluate them regarding to East Mediterranean Region based on Analytic Network Process and SWOT Analysis for conducting integrated impact assessment. To do so, the proposed model is applied in three basic stages. In the first stage, the efficient strategic factors (Strengths, Weaknesses, Opportunities and Threats) and the appropriated strategies, SO, ST, WO and WT are determined via the SWOT analysis. SWOT factors as criteria, SWOT sub-factors as the sub-criteria and the strategies as alternatives are placed in downward order of hierarchy structure. A study team was employed to identify the internal and environmental strategic factors to fulfill the strategic planning analysis. Weights of criteria and sub-criteria are prioritized via ANP in

the second stage. Linguistic terms shown in Table 5 are used to evaluate criteria weights. At last stage, final priorities of strategies are obtained in ANP analysis.

Schematic diagram of the proposed model for distance education websites evaluation is shown at Figure 4.

According to Figure 4, the goal – natural gas strategies in East Mediterranean Region – is determined firstly, and then the team of experts is made. After the determination of strengths, weaknesses, opportunities and threats of the natural gas policies, SWOT matrix is built. By obtaining the pairwise comparisons from experts, weights are calculated via ANP. Finally, alternative strategies are evaluated and ranked.

Table 5. 1–9 scale used for criteria comparisons (Saaty 1996)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of above non-zero numbers	if activity <i>i</i> has one of the above non-zero numbers assigned to it when compared with activity <i>j</i> , then <i>j</i> has the reciprocal value when compared with <i>i</i>	

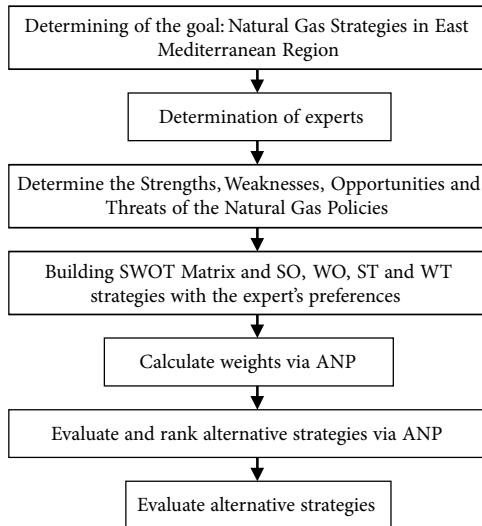


Fig. 4. An overview of the proposed model

3. Application of the proposed model

This section describes the application of proposed SWOT-ANP approach on evaluating natural gas strategies in East Mediterranean Region. The Eastern Mediterranean denotes the countries geographically to the east of the Mediterranean Sea. The countries of the Eastern Mediterranean include: Cyprus, Greece, Lebanon, Syria, Israel, State of Palestine, Turkey, Egypt, Jordan, and Libya. Hierarchy structure of problem is defined to select best natural gas strategy/policy of Eastern Mediterranean region as goal placed at the top of hierarchy. Bottom of the hierarchy structure is constructed by a study team. Two experts from Ministry of Energy and Natural Resources and four authors have participated to the study. In SWOT analysis, 20 sub-criteria are determined by experts and then the main natural gas strategies based on interactions between SWOT sub-factors and expert's ideas were grouped into 7 major strategies. Obtained SWOT matrix is shown in Table 6. To give a detailed explanation, SO-1: Use geostrategic position to be the main energy hub in the East Mediterranean Region, this strategy uses Turkey's internal strengths (geostrategic position) in order to take advantage of external opportunities, such as joining the new formations in energy transportations or security. WO-1 strategy depicts improving internal weaknesses by taking advantage of external opportunities. WO-1 strategy presumes the support of Europe. The other strategy is ST-1 which uses strengths to avoid or reduce the impact of external threats. For Turkey, trying to build up regional economic unions and decrease the instability in the East Mediterranean Region brings an option for the energy strategies. Lastly, we use WT strategies to reduce the internal weaknesses and avoiding environmental threats.

After determination the strategies in other words the alternatives, interactions between sub-criteria are needed to be determined. It means that some criteria can affect each other's priorities. Table 7 gives the interactions between sub-criteria. For instance, the criterion "W-1: A failure to achieve global competitiveness" is affected by W-5: Lack of energy transportation infrastructure and T-5: Environmental threat and cost of the energy transportation.

All relationships between the sub-criteria are illustrated in Figure 5. In Figure 5, one-sided arrow shows the criterion which is influenced by the other criteria while a two-sided arrow between two criteria shows that two criteria affect each other.

The ANP method allows for complex interrelationships among attributes and uses pairwise comparisons to determine criteria weights. Main criteria under the goal are paired and the following question: "which criterion is more important than the other?" is asked to the expert team. The experts select one criterion and then determine the degree according to the scale in Table 5. At the last step, a super matrix which is actually a partitioned matrix is formed and criteria weights are calculated by getting limit matrix. The software "Super Decisions" directs users to solicit evaluations, then applies these steps automatically and makes the process easier for users. This is the reason that we, the author(s) of this paper, prefer to use the software in our study. After the network structure is built, the software directs the user to the assessment and comparisons for each criterion are applied. The pairwise comparison matrix for the sub-criteria in the cluster named system quality is shown in Figure 6. The blue number and arrow show that the criterion in the row is more important than the criterion in the column. The red ones show the other situation. For instance, WT-1 is 1.6

Table 6. SWOT matrix of natural gas for Turkey

Internal Factors	Strengths <ol style="list-style-type: none"> 1. An energy hub, not simply energy corridors (S-1). 2. Strong military power (including navy power) to secure the energy corridors (S-2). 3. A role of stable country in the South Mediterranean Region (S-3). 4. Dedicated and strong government (S-4). 5. Implement plans to improve energy transportation (S-5). 	Weaknesses <ol style="list-style-type: none"> 1. A failure to achieve global competitiveness (W-1). 2. An increasing population and energy need (W-2). 3. Over urbanization (W-3). 4. Economy, fast developing but not one of the main decision maker (W-4). 5. Lack of energy transportation infrastructure (W-5).
External Factors	SO Strategies <ol style="list-style-type: none"> 1. Use geostrategic position to be the main energy hub in the East Mediterranean Region (SO-1). 2. Use political support from international community for being the main energy hub in the East Mediterranean Region (SO-2). 	WO Strategies <ol style="list-style-type: none"> 3. Compensate the lack of energy transportation infrastructure by the support of Europe (WO-1). 4. Adopt new rules for overcoming the financial difficulties on the strength of geostrategic position (WO-2).
Opportunities <ol style="list-style-type: none"> 1. Proximity to Russia and Central Asia Energy Providers (As an alternative energy suppliers) (O-1). 2. Proximity to Europe, one of the biggest energy markets (O-2). 3. Membership to the most important international organizations (NATO, OPEC, etc.) (O-3). 4. Political support of the international community for the projects (O-4). 5. The shortest distances for the energy transportation to Europe (O-5). 	ST Strategies <ol style="list-style-type: none"> 5. Try to build up regional economic unions and decrease the instability in the East Mediterranean Region (ST-1). 6. Have continuous and consistent plans to improve energy transportation (ST-2). 	WT Strategies <ol style="list-style-type: none"> 7. Have new alliances to be new global actor in energy issue (WT-1).
Threats <ol style="list-style-type: none"> 1. Highly dependent to external energy suppliers (T-1). 2. Unstable neighbors (T-2). 3. Poor relations with Israel and Greek Cypriot Administration of Southern Cyprus (T-3). 4. The latest incidents in Middle East Countries (T-4). 5. Environmental threat and cost of the energy transportation (T-5). 		

Table 7. SWOT matrix and connections

SWOT Matrix	Connections
Strengths <ol style="list-style-type: none"> 1. An energy hub, not simply energy corridors (S-1) 2. Strong military power (including navy power) to secure the energy corridors (S-2) 3. A role of stable country in the South Mediterranean Region (S-3) 4. Dedicated and strong government (S-4) 5. Implement plans to improve energy transportation (S-5) 	<p>S-5, W-5, O-1, O-2, O-5, T-2 S-3, S-4, T-2, T-3, T-4</p> <p>S-2, S-4, O-1, O-2, T-2, T-3, T-4</p> <p>S-2, S-3, S-5, O-3, T-2, T-3 S-1, S-4, W-3, W-4, W-5, O-1, O-2, O-3, O-5, T-1, T-5</p>

SWOT Matrix	Connections
<p>Weaknesses</p> <ol style="list-style-type: none"> 1. A failure to achieve global competitiveness (W-1) 2. An increasing population and energy need (W-2) 3. Over urbanization (W-3) 4. Economy, fast developing but not one of the main decision maker (W-4) 5. Lack of energy transportation infrastructure (W-5) 	<p>W-5, T-5 W-3, W-4, S-5, T-1 W-2, T-1, T-2, T-4 S-3, S-4, S-5, O-2 S5, W1, W4, T5</p>
<p>Opportunities</p> <ol style="list-style-type: none"> 1. Proximity to Russia and Central Asia Energy Providers (O-1) 2. Proximity to Europe, one of the biggest energy markets (O-2) 3. Membership to the most important international organizations (NATO, OPEC) (O-3) 4. Political support of the international community for the projects (O-4) 5. The shortest distances for the energy transportation to Europe (O-5) 	<p>O-2, O-3, O-5 O-1, O-3, O-4, O-5, S-3, S-4 S2, S3, S-4, O-4, T-2 S2, S-3, S-4, S-5, O-2, O-3, O-5 O-1, O-2, T-3</p>
<p>Threats</p> <ol style="list-style-type: none"> 1. Highly dependent to external energy suppliers (T-1) 2. Unstable neighbors (T-2) 3. Poor relations with Israel and Greek Cypriot Administration of Southern Cyprus (T-3) 4. The latest incidents in Middle East Countries (T-4) 5. Environmental threat and cost of the energy transportation (T-5) 	<p>S-1, S-5, W-2, W-3, O-1 S-2, S-3, S-4, O-3, T-4 S-2, S-3, T-2, T-4 S-2, S-3, T-2, T-3 S-1, S-3, W-5, O-2, O-5</p>

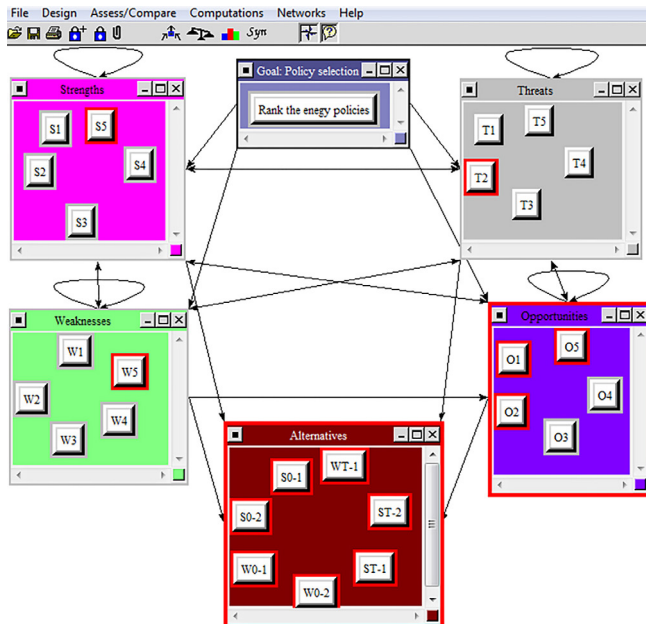


Fig. 5. The network structure of the criteria evaluation

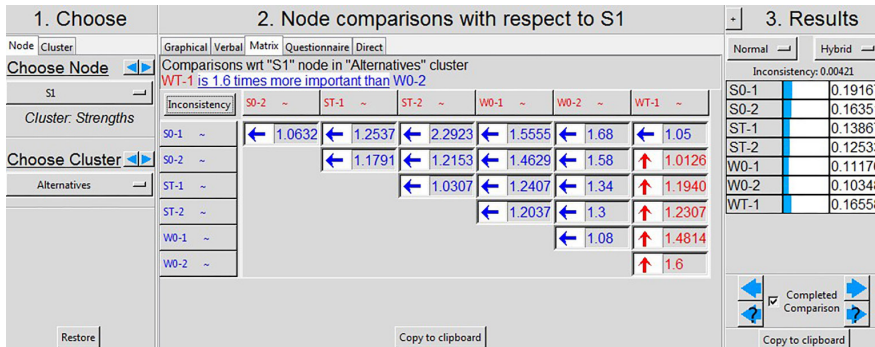


Fig. 6. The pairwise comparison matrix of alternatives based on S1 criterion

times more important than WO-2. The ANP method requires the inconsistency ratio (CR) to be smaller than 0.1; this that means the user makes the evaluations consistently. CRs of the all pairwise comparison matrixes in the model are smaller than 0.1. All other pairwise comparison matrixes are done in similar way. Evaluations are then completed and the criteria priorities are calculated as given in Table 8.

Table 8. The criteria priorities obtained by ANP

SWOT Matrix	Priorities
Strengths	
1. An energy hub, not simply energy corridors (S-1)	0.00762
2. Strong military power (including navy power) to secure the energy corridors (S-2)	0.11761
3. A role of stable country in the South Mediterranean Region (S-3)	0.08854
4. Dedicated and strong government (S-4)	0.11580
5. Implement plans to improve energy transportation (S-5)	0.04165
Weaknesses	
1. A failure to achieve global competitiveness (W-1)	0.00279
2. An increasing population and energy need (W-2)	0.00469
3. Over urbanization (W-3)	0.00868
4. Economy, fast developing but not one of the main decision maker (W-4)	0.00386
5. Lack of energy transportation infrastructure (W-5)	0.01193
Opportunities	
1. Proximity to Russia and Central Asia Energy Providers (O-1)	0.01948
2. Proximity to Europe, one of the biggest energy markets (O-2)	0.05499
3. Membership to the most important international organizations (NATO, OPEC, etc.) (O-3)	0.11428
4. Political support of the international community for the projects (O-4)	0.04429
5. The shortest distances for the energy transportation to Europe (O-5)	0.02886
Threats	
1. Highly dependent to external energy suppliers (T-1)	0.00542
2. Unstable neighbors (T-2)	0.15359
3. Poor relations with Israel and Greek Cypriot Administration of Southern Cyprus (T-3)	0.04857
4. The latest incidents in Middle East Countries (T-4)	0.11309
5. Environmental threat and cost of the energy transportation (T-5)	0.01426

Then the relative weights obtained from the analysis of paired comparisons tables for ranking the alternatives are calculated. Obtained weights of seven alternatives are given in Table 9.

Based on the achieved weight in Table 9, ST-1 strategy “*Try to build up regional economic unions and decrease the instability in the East Mediterranean Region*” is the highest weight. On the contrary, strategy WO-1 “*Compensate the lack of energy transportation infrastructure by the support of Europe*” is the worst policy.

Table 9. The priorities of alternatives obtained by ANP

	Alternative strategies	Priorities
SO	Use geostrategic position to be the main energy hub in the East Mediterranean Region (SO-1)	0.158734
	Use political support from international community for being the main energy hub in the East Mediterranean Region (SO-2)	0.164214
ST	Try to build up regional economic unions and decrease the instability in the East Mediterranean Region (ST-1)	0.176513
	Have continuous and consistent plans to improve energy transportation (ST-2)	0.142502
WO	Compensate the lack of energy transportation infrastructure by the support of Europe (WO-1)	0.095865
	Adopt new rules for overcoming the financial difficulties on the strength of geostrategic position (WO-2)	0.121115
WT	Have new alliances to be new global actor in energy issue (WT-1)	0.141046

3.1. Application of different solution approaches

In addition to current solution approach (SWOT-ANP), extra methods are applied to evaluate natural gas strategies of Turkey in this section. Table 10 presents the applied integrated solution approaches with their definition. Pairwise matrixes of ANP are also used for AHP. For simplicity sake, the calculation steps of the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method are not presented. However, they are available upon request.

While Table 11 gives the priorities of criteria obtained by AHP, ranking weights of strategies obtained by TOPSIS are given in Table 12.

Table 10. Applied solution approaches

Abbreviation	Definition
Method1 (Current solution)	Strategies by SWOT, weighted and ranked by ANP
Method2	Strategies by SWOT, weighted and ranked by AHP
Method3	Strategies by SWOT, weighted by ANP, ranked by TOPSIS
Method4	Strategies by SWOT, weighted by AHP, ranked by TOPSIS
Method5	Strategies by SWOT, weighted equally, ranked by TOPSIS

Table 11. The criteria priorities obtained by AHP

Strengths	Priorities	Weaknesses	Priorities	Opportunities	Priorities	Threats	Priorities
S-1	0.00518	W-1	0.00112	O-1	0.03919	T-1	0.00470
S-2	0.11478	W-2	0.00246	O-2	0.05063	T-2	0.13712
S-3	0.13211	W-3	0.00345	O-3	0.10810	T-3	0.08801
S-4	0.10057	W-4	0.00374	O-4	0.04429	T-4	0.10362
S-5	0.02312	W-5	0.00633	O-5	0.02542	T-5	0.00605

Table 12. Ranking obtained by TOPSIS

Strategies	Method 3			Method 4			Method 5		
	S_i^*	S_i^-	C_i	S_i^*	S_i^-	C_i	S_i^*	S_i^-	C_i
SO-1	0.02311	0.02819	0.54953	0.02236	0.02749	0.55143	0.01854	0.01791	0.49136
SO-2	0.02150	0.02991	0.58188	0.02058	0.02943	0.58846	0.01758	0.01837	0.51097
ST-1	0.01381	0.03764	0.73160	0.01378	0.03724	0.72995	0.01758	0.01893	0.51849
ST-2	0.03031	0.02531	0.45509	0.03199	0.02232	0.41096	0.01673	0.02259	0.57457
WO-1	0.04078	0.00630	0.13376	0.04019	0.00575	0.12525	0.02496	0.01227	0.32963
WO-2	0.03574	0.01914	0.34876	0.03474	0.01824	0.34421	0.02082	0.01590	0.43302
WT-1	0.02965	0.02360	0.44319	0.02788	0.02407	0.46333	0.02096	0.01701	0.44792

Figure 7 illustrates the final rankings of strategies according to each applied method by using the data in Tables 11 and 12. Strategies' ranks calculated with the method 5 are a little different depending on equal criteria weights. It is the fact that criteria weights differ according to countries, the time on which strategies are evaluated. As a result, ranks calculated with the first four methods are more logical than the last one.

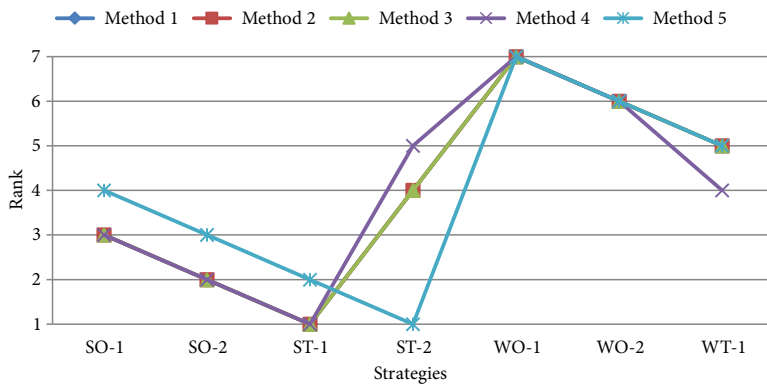


Fig. 7. Comparison of different solution approaches

3.2. Discussion

A SWOT ANP hybrid method is performed to evaluate and rank the natural gas strategies of Turkey based on the conditions of Eastern Mediterranean Region. The main reason of using ANP is to consider possible dependency among factors, sub-factors and alternatives (strategies). Different solution approaches such as AHP and TOPSIS are applied to see the changes on ranking. It is obvious that consideration of the different methods causes remarkable changes in ranking alternatives especially about high important alternatives. The overall computed priorities for alternative strategies shows that SO-2 and ST-1 strategies are the best strategies. Using political support from international community for being the main energy hub in the East Mediterranean Region and trying to build up regional economic unions and decrease the instability in the East Mediterranean Region is determined as the best strategies for natural gas policy of Turkey.

These strategies could be the best strategies when you consider the all alternatives in the beginning without using quantitative methods. We showed the applicability of hybrid MCDM methods over the energy strategies of Turkey. We also tried to demonstrate that the strategies should be decided by based on mathematical approaches, not conventional decision making methods. For that reason, we applied hybrid MCDM methods to get solid results from the strategies derived by the experts.

The results show that potential of economic unions in the region is the most important opportunity for Turkey's natural gas strategies. Also if Turkey can get a political support from the rest 9 East Mediterranean Region countries to be an energy hub in the region, she would take the opportunity to increase natural gas share.

Conclusions

Energy is needed for everything; to power homes, drive cars, to use technology and even to feed and clothe human beings. Energy underpins modern life and that's why it's the issue of our time. Natural gas is the most important form of energy because it is clean, abundant, reliable and versatile. Thus it will play a key role in ensuring people's energy demands in the future. Like all the resources in nature, sharing natural gas resources can cause chaos over the energy regions.

The conflicts and disputes in an energy region are forcing the countries to implement suitable strategic energy policies based on scientific methods. The decision context is related not only with the energy supply/demand, but also with the political, environmental, administrative, legal and market issues. Therefore, using a scientific and efficient method to select the best strategies is inevitable. In this study, an integrated SWOT-ANP approach is applied to evaluate natural gas policies of Turkey for the East Mediterranean Region. The strategies are determined via SWOT analysis including four criteria, 20 sub-criteria and seven strategies. The ANP approach that considers the dependency between factors is applied to prioritize these strategies. Different solution approaches such as AHP and TOPSIS are applied to see the changes on ranking. Consideration of different methods causes remarkable changes in ranking alternatives. Results show that, SO-2 and ST-1 strategies are determined as the best

strategies. That means; “Using political support from international community for being the main energy hub in the East Mediterranean Region” and “Trying to build up regional economic unions and decreasing the instability in the East Mediterranean Region” are the best strategies for natural gas policies of Turkey. According to obtained results, it is shown that proposed integrated approach is an effective and applicable tool for energy policy making considering the real life conditions. Although one can think that scientific techniques can be useless on political or strategic decisions, scientific methods can help decision makers if the problem is revealed properly.

Future research can be performed based on dependency effects between SWOT sub-factors and strategies. In addition to applying this model to the different energy resource types, different MCDM techniques or fuzzy methods can be implemented on the same problem.

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