

## **The Environmental Strategic Analysis of Oil & Gas Industries in the Kurdistan Region Using PESTLE, SWOT and FDEMATEL**

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Received: 12.02.2018

Accepted: 28.02.2018

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**ABSTRACT:** The need for oil and natural gas as a major source of energy is vital. On the one hand, it has affected the political and economic equations at the international, regional and national level. On the other hand, it has had negative effects on sociocultural, legal, and environmental aspects as well as on the physical and mental health of human beings. Therefore, the need to provide an environmental policy that addresses the various dimensions of the oil and gas industry will be necessary. The present paper aims to set up a conceptual model of environmental policy for sustainable development in the oil and gas industries of the Kurdistan Region through the use of these 6 components: political, economic, sociocultural, technological, legal and environmental. It will also be using the techniques of PESTLE, SWOT, SPACE, FANP, FDEMATEL, and simulation with the VENSIM software. The results show the weights of the criteria respectively are Political; 1.59, Economic; 0.78, Sociocultural; 0.00, Legal; -0.99, Technological; -0.61 and Environmental; -0.70. So that all components are important, but that political and economic factors have a significant influence on environmental policies and oil and gas industries. Sociocultural components have a neutral role and the technological, legal and environmental components are impressible. Finally, fifteen strategies for the formulation of an effective environmental policy in the oil and gas industry were presented.

**Keywords:** Environmental policy, oil and gas industries, sustainable development, Kurdistan Region.

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### **INTRODUCTION\***

Population growth, economic development and energy consumption are constant (Bianco, 2014). Therefore, the economic and environmental impacts due to increased energy consumption have been considered (Rimos et al., 2014). Humans are dependent on the environment and use the environment to prepare their basic needs, such as food, fuel, livestock, minerals and vital systems such as the climate (Erickson & King, 1999). It is

expected that the remaining liquid fuels and natural gas, which are the main sources of energy on the long horizon, have been reduced by 50% from the initial amount (IEA, 2013). Also, according to recent estimates, global energy consumption will have increased by 41% over the next two decades (Melikoglu, 2014). The Kurdistan region is an important area for energy and contains about 60 billion barrels of oil and 200 trillion cubic meters of natural gas. For example, during the first six months of 2017, oil exports numbered 100,691,642 and local consumption numbered

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10,160,635 (KRG, 2017). The exploration and production of oil and natural gas have the potential for extreme environmental degradation. In addition, the global crisis is the current model of economic growth that has affected all aspects of sustainability-ecological and social economies. The revision through measuring future economy and energy use to preserve production, consumption of goods and services is important (Chauhan & Saini, 2014). Therefore, a comprehensive understanding of its performance is needed not only to decide on domestic energy policies (investments and subsidies) but also to develop sustainable economic policies (Harris & Roach, 2017).

In developing countries, including Iraq and Kurdistan, the problems caused by the oil and gas industries have penetrated political, economic, sociocultural, legal and environmental issues. Environmental laws are often ineffective and insufficient (Wawryk, 2003). Therefore, the need for a power that protects law enforcement is vital. Environmental policies (a set of rules and solutions) have been formed according to the need and understanding of a specific topic, and their purpose is to get rid of critical situations and problems (Cohen, 2014). In addition, protecting the environment in direction of the growth and development of human civilization is critical. Integration of environmental dimensions has also been considered as one of the principles of ecological renewal in the other political areas, such as energy, agriculture and transportation, and it is the forefront of sustainable development (Eckerberg, 2009). One of the environmental goals is to achieve environmental protection by integrating ecology, policymaking, planning and social development, and other goals can include identifying threats and opportunities, sustaining and, if possible, developing existing resources (Kullkarni & Ramachandra, 2006). Oil and gas resources face a lot of limitations, and planning and

policymaking for oil and gas resources are becoming increasingly important. Optimal planning for oil and gas development projects is an important issue because in the long term, the relevant investment decisions are irreversible and huge financial resources are spent (Huseby & Haavardsson, 2009). It is often argued that among activities of the oil sector that are technical with overuse of capitals, the emerging rich economies do not benefit from oil, especially those with no significant industrial base (Ovadia, 2013). Countries' oil resources have not had a significant economic impact on these countries' populations due to the fact that a large part of the activities of this sector, especially service contracts, has been applied by foreign oil companies (BellemaIhua et al., 2011). What is required in carrying out the projects is that decisions on the project must be justly, fair and transparent, and decision-makers must be responsible for their decisions. Observance of the principle of democratic equality and respect for human values to preserve cultural and environmental diversity is the only way in front of the Kurdish regional government to have a good place in the regional and international arena. Therefore, this research has been done.

Dargin published a paper titled peacekeeping: The war on ethnicity and energy in modern Iraq, the basic proposal of this paper is to create the governance of hydrocarbon law and transparency to reduce energy controversy, rebuild Iraq and eliminate sectarian tension (Dargin, 2009). In the case of petro-capitalism in Kurdistan Iraq, Gray has identified four threats to the future of Iraq, which are, firstly, the creation and increase of ethnic sectarian warfare; secondly, the issue of Kirkuk (although a referendum was held on 25.9.2017 and about 92% of the Kurdish people, along with the people of the disputed areas too, voted for the independence of Kurdistan, the international community did not support

the referendum. After the referendum and the martyrdom of several Peshmerga, and the vagrancy of more than 220,000 people, the Iraqi Army and the Hashd al Shaabi entered Kirkuk); thirdly, the failure of Iraqi politicians to implement the comprehensive hydrocarbon law; fourthly, the establishment of a strong religious government (Chase, 2012). Al Fadel et al. conducted research in the Middle East and North Africa region using the SWOT analysis method. They stated that the countries of the Middle East and North Africa were developing into effective environmental strategic assessment systems (El Fadel et al., 2013).

Wahab (2015), in his PhD dissertation about oil federalism in Iraq, studied the disaster of resources, support and sustainability networks, and the emergence of ISIS. The results showed that politics in Iraq has worsened the disaster of sources and instability (Wahab, 2015). Al Saleem studied the legal framework for the sustainable development of Iraq's oil and gas, especially the Kurdistan region, underlining the Declaration of Delhi. The social and economic gap at the local and international levels is the root cause of the problems in Iraq, causing sectarian and ethnic conflicts (Al saleem, 2015). Aresti investigated Iraq's oil and gas revenue division, and discovered the transfer of oil and natural gas to the Kurdistan region, the petrodollar issue and the rural development program (Aresti, 2016). Sovacool conducted a study on coping with corruption, energy justice, natural resource funds and São Tomé e Príncipe oil revenue management law. The results showed that minimizing corruption and exploitation was often linked to the exploration and production of oil. It must be ensured that energy revenues are used for the benefit of the general public (Sovacool, 2016). Fozer et al., in a paper using PESTLE and multi-criteria decision analysis, reviewed the life cycle and carbon storage alternatives. The

results showed that the recovery of CCS technology attraction is more favorable than uncontrolled carbon emissions (Fozer et al, 2017).

The present study regarding environmental policy of oil and gas industries, and sustainable development, identified and evaluated the effective political, economic, socio-cultural, technological, legal and environmental components and sub-components (there were 68 subcomponents). In this regard, FDEMATEL, FANP, SPACE, SWOT, PESTLE as well as VENSIM software were used.

## **MATERIALS AND METHODS**

The geography of the Kurdish region includes the north and northeastern part of Iraq, with coordinates 36 ° 11'N 44 ° 00'E. This region includes a joint border with eastern Iran, northern Turkey, western Syria, and other parts of southern Iraq. The Kurdistan region has an area of 90,000 km<sup>2</sup> and according to the 2014 estimates, Kurdistan Region population was 5,122,747 individuals (KRSO and SCO, 2018). Iraqi Kurdistan has been divided among six provinces; the Kurdistan Regional Government is dominant on the four provinces of Erbil, Sulaymaniyah, Dahuk, Halabja and parts of the provinces of Ninewa, Diyala and Kirkuk (Fig. 1).

PESTLE analytical techniques have been used to develop the conceptual framework of the environmental policy of the oil and gas industry and to achieve the goals of sustainable development. Relationships and the impact of the variables are presented by the VENSIM software as shown in Figure 4.

Analytical technique refers to the first source used by Francis G Aguilar, who was the first person in 1967 to use the term for the scanning tools and techniques of the work environment. PESTLE includes political, economic, social, cultural, technological, legal and environmental factors (Johnson et al., 2008).



Fig. 1. Political map of the Kurdistan Region (Chapman, 2009).

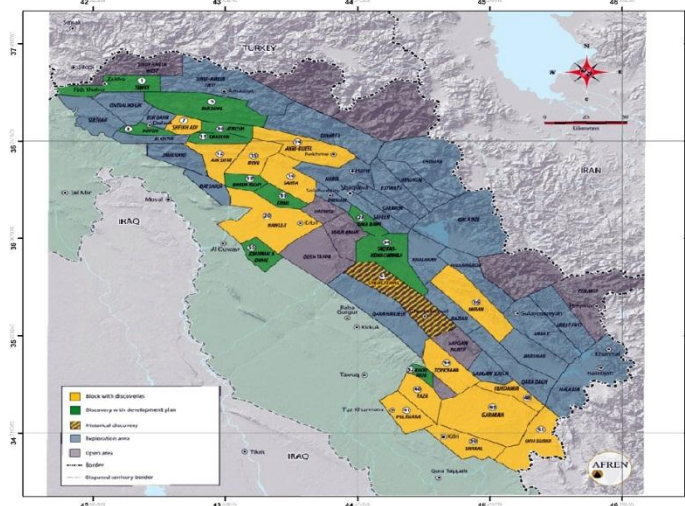


Fig. 2. Discoveries and development oilfields in Kurdistan Region

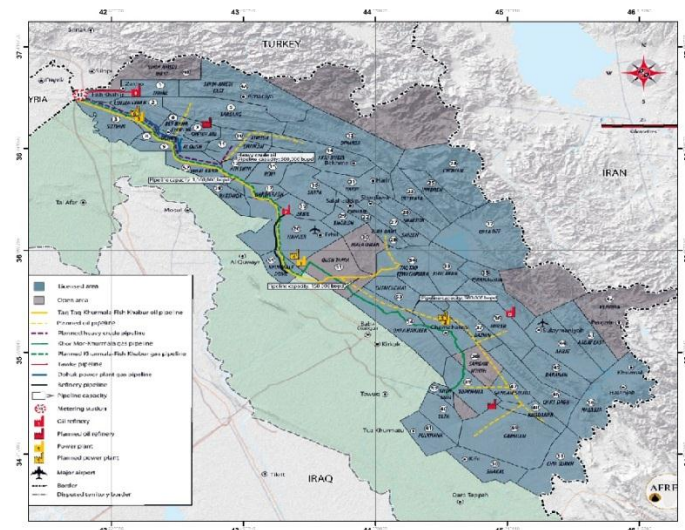


Fig. 3. Licenses and energy infrastructures in Kurdistan region (KRG, 2013).

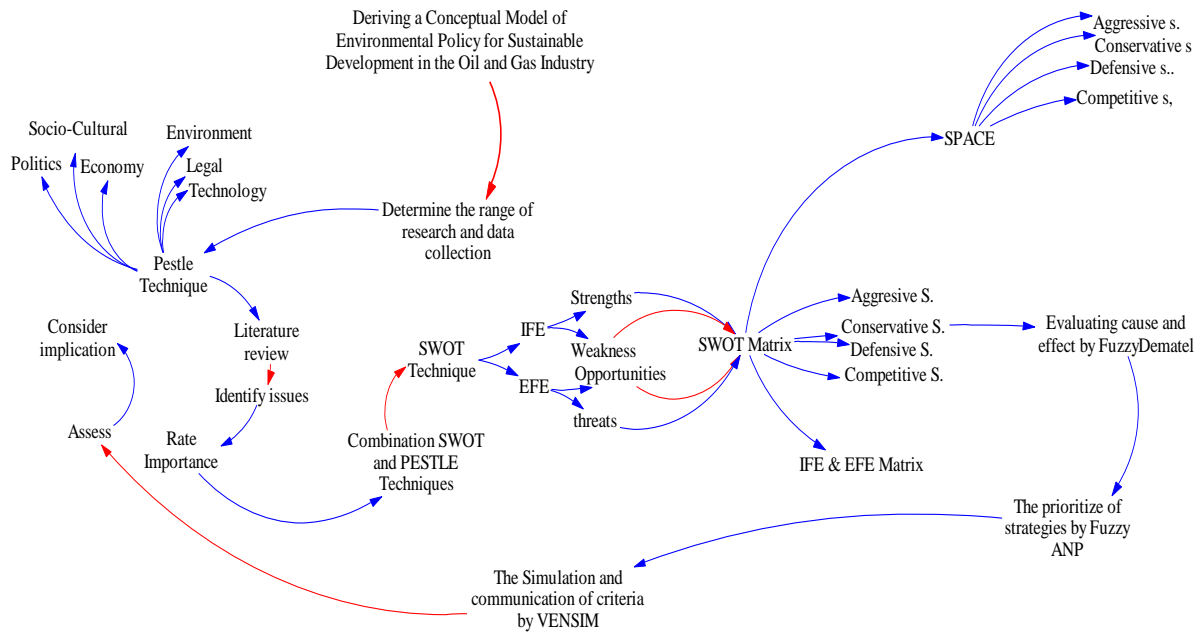


Fig. 4. Research process.

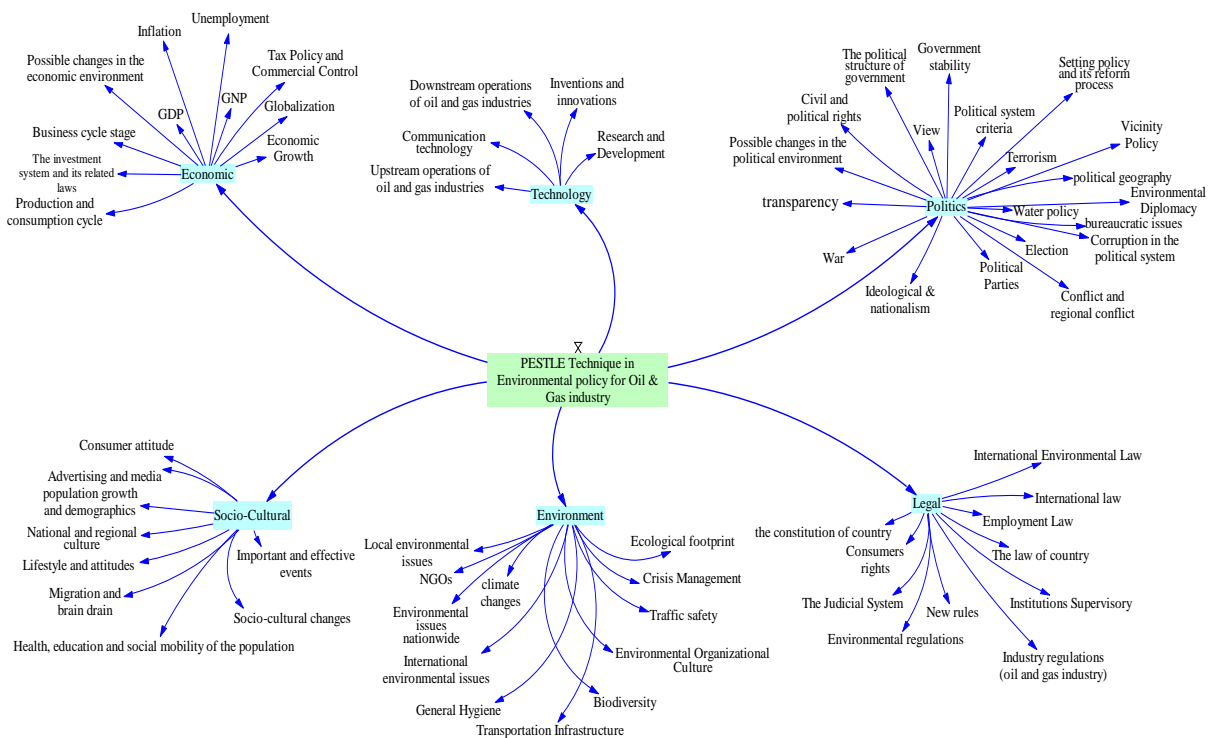


Fig. 5. Components and sub-components (source: Author).

The SWOT technique was first introduced in 1950 by two graduates from Harvard Business School, named George Albert Smith and Roland Christensen (Duarte et al, 2006). Internal and external factors in the SWOT analysis are

abbreviations of the following words: strengths, weaknesses, opportunities and threats (Griffin, 2013). Internal and external factors are identified and weighed by experts, as shown in tables 1 and 2.

**Table 1. Internal factors evaluation matrix (IFE)**

Row	Strengths and weaknesses	Weight	Score	Weighted score
1	Existence of oil and gas resources in the region	0.09	4	0.36
2	Democracy and the preservation of civil and political rights	0.07	4	0.28
3	Economic flourish and growth of GNP and GDP	0.06	4	0.24
4	Weakness in strategic planning and macro policymaking	0.04	4	0.16
5	Lack of a solid and robust management system in line with financial transparency and contracts	0.05	3	0.15
6	The inefficiency of the tax and customs system	0.04	3	0.12
7	Existence of enough water supplies for use in the oil and gas industries	0.03	4	0.12
8	Lack of oil and gas infrastructures (petrochemicals, refineries, downstream industries, exhaustion, and maintenance)	0.05	2	0.1
9	Relative upgrade of communications and technology infrastructures	0.03	3	0.09
10	Lack of coordination among supply and demand and domestic needs	0.03	3	0.09
11	Higher education policy and student education in the universities and scientific centers of the developed countries in the world	0.03	3	0.09
12	Promotion of cultural and social infrastructures	0.04	2	0.08
13	Lack of transparency in finance and contracts	0.07	1	0.07
14	The legal gap in the administration of national affairs, especially in the oil and gas area	0.06	1	0.06
15	Lack of professional manpower and HSE culture	0.03	2	0.06
16	Low inflation rate (at zero level)	0.06	1	0.06
17	The absence of specialized, efficient, domestic private companies	0.03	2	0.06
18	Creating broad employment	0.06	1	0.06
19	Poor knowledge and information of employees working in this industry	0.05	1	0.05
20	Lack of communications and technology infrastructures	0.05	1	0.05
21	Existence of various nongovernmental organizations in the field of environmental protection	0.03	1	0.03
Total		1		2.38

Total weighted score of internal factors = 2.38

It suggests that oil and gas industries have more weaknesses than strengths. Regarding this result, it can be seen that the Kurdistan region, despite its rich oil resources, is not economically efficient. This is also due to problems in management and current policies, which have not been able to overcome weaknesses and increase strengths.

This suggests that the environmental policy of the oil and gas industry has more opportunities than threats. Regarding external factors, the Kurdistan Region has more opportunities, which can be taken to further improve the strengths compared to the weaknesses and reduce the number of threats.

**Table 2. External factors evaluation matrix (EFE)**

Row	Threats and opportunities	Weight	Score	Weighted score
1	The world's need for energy in the future	0.05	4	0.2
2	Not having political boundaries and connecting to the free waters of the world	0.05	4	0.2
3	Financial and administrative corruption	0.04	4	0.16
4	Security problems	0.02	3	0.06
5	Integration of protection and development	0.04	4	0.16
6	Investment problems	0.02	2	0.04
7	Risk of estimating available reserves	0.02	2	0.04
8	Lack of optimal use and low efficiency of energy	0.02	2	0.04
9	Regional and foreign political threats	0.03	2	0.06
10	Lack of coordination among governmental organs	0.02	3	0.06
11	Overuse of existing reserves	0.04	2	0.08
12	Low awareness of the environment	0.02	2	0.04
13	Natural and accidental disasters	0.02	2	0.04
14	Instability in international oil and gas markets (prices)	0.02	2	0.04
15	Political problems and barriers between the central government and the regional one	0.03	2	0.06
16	Change of consumption patterns	0.03	2	0.06
17	Construction of oil and gas transmission lines from different countries (Iraq, Iran, Syria, and Turkey)	0.04	4	0.16
18	The support and investment of the global banks in the region	0.03	4	0.12
19	The investment of large foreign companies in the oil and gas industry of the region	0.02	4	0.08
20	The improvement of good political and business relations with the countries of the region and the world	0.02	4	0.08
21	The presence of embassies and consulates in different countries of the world	0.03	4	0.12
22	Development of the infrastructures of oil and gas industries and their downstream industries	0.02	4	0.08
23	Social and cultural problems (ethnic wars)	0.03	4	0.12
24	Creation and development of research centers	0.03	4	0.12
25	The existence of good communication and media infrastructures both nationally and internationally	0.02	3	0.06
26	Providing investment opportunities for large, foreign financial companies	0.02	4	0.08
27	The existence of good conditions for the development and implementation of national and international environmental laws	0.02	4	0.08
28	Activities of international environmental organizations	0.01	3	0.03
29	The activities of human rights and international organizations	0.01	3	0.03
30	Representation of the Kurdistan Regional Government in different countries of the world	0.01	3	0.03
31	Population growth (young population)	0.02	3	0.06
32	Investing in collecting gases that burn in flares	0.02	3	0.06
33	Achieving energy security	0.03	4	0.12
34	Investments in different sectors can be made using part of the oil revenue.	0.02	4	0.08
35	Achieving the principles of democracy and creating a credible global economic system	0.04	4	0.16
36	Improvement and development of technology and communications	0.02	3	0.06
37	Provision of a transparency system in contracts and management of oil and gas finance	0.02	4	0.08
38	Urban and rural planning and development	0.01	3	0.03
39	Creating data collection system	0.01	3	0.03
40	Planning and improving cultural conditions	0.01	3	0.03
41	Diversification of energy sources	0.01	3	0.03
42	Cultural problems of society	0.01	3	0.03
Total		1		3.3

The total weighted score of External Factors (EFE) = 3.3

Strategic position evaluation matrix of the internal and external factors of environmental policy in the oil and gas industries was used. The results indicated that the strategic situation of the oil and gas industries in the Kurdistan region with the approach of environmental policy to achieve sustainable development has been placed in the conservative strategies section (dominance of opportunities over threats and weaknesses over strengths) below as shown in Figure 6.

SPACE is a special technique to evaluate specific strategies. This matrix is used to compare internal and external factors of the company and includes two internal dimensions of financial strength (FS) and competitive advantage (CA) and

two external dimensions of environmental stability (ES) and industrial strength (IS) (Gurbuz, 2013). The Following results were obtained after being scored by experts. as shown in Figure 7.

Total scores of financial strength factors = 2.62

Total scores of competitive advantage factors = -1.8

Total scores of environmental stability factors = -3.95

Total scores of industrial strength factors = 4.21

The results of axes X and Y are: the sum of data on the horizontal axis (CA-IS) = 2.41

Total data on the vertical axis (ES-FS) = -1.33

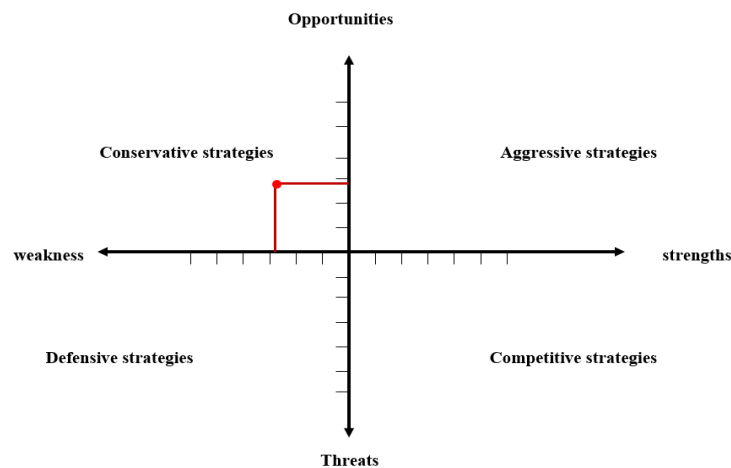


Fig. 6. Explaining the position of in Kurdistan

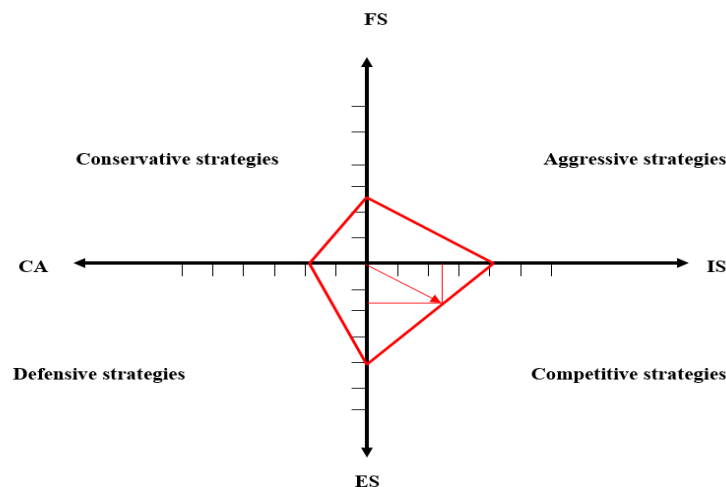


Fig. 7. Assessing the position and environmental policy strategic action in SPACE



**Table 3. SWOT matrix for the purpose of integrating the factors and strategic action of environmental policies in the oil and gas industries of the Kurdistan region**

I & E factors	Strengths (S)	Weaknesses (W)
<b>Opportunities (O)</b>	<p>Strength *Opportunity Strategies</p> <p>SO1- The developmental policy of oil and gas reserves to meet energy needs in the world.</p> <p>SO2- Use of international loans and supports to develop job creation and economic prosperity.</p> <p>SO3- Improvement of the tax structure and provision of more facilities for foreign companies' activities and attraction of other companies.</p> <p>SO4- Using the embassy and consulate of various countries in the Kurdistan Region to promote democracy as well as civil and political rights.</p> <p>SO5- Development of research infrastructures in oil and gas industries for sustainable development.</p> <p>SO6- Effective use of domestic and international communication and media infrastructure to promote cultural and social infrastructures.</p> <p>SO7- Use of support from international environmental organizations to establish and strengthen environmental and public non governmental organizations.</p> <p>SO8- The use of the activities of human rights organizations and international transparency in the field of social justice and the establishment of the principles of democracy.</p> <p>SO9- Teaching and training specialized people from the young population and their application in the development of the country and the oil and gas industry.</p> <p>SO10- Investment in collecting gases which burn in flares and prevention of the waste of millions of dollars per year.</p> <p>SO11- Providing energy supply security, competition and environmental protection</p>	<p>Weakness *Opportunity Strategies</p> <p>WO1- Application of human rights and international transparency to counteract financial and administrative corruption in the oil and gas industries.</p> <p>WO2- Development of management infrastructures to create and strengthen a management system in the oil and gas industry.</p> <p>WO3- Financial supportive policies in the oil and gas industry in line with increasing professional and specialized manpower, as well as the efficiency of domestic and foreign private companies.</p> <p>WO4- Planning the development, approval and establishment of a health, safety and environment management system in the oil and gas industries.</p> <p>WO5- Developing a strategic plan for the recognition and development of energy resources (renewable and non renewable energy).</p> <p>WO6- The use of external facilities to advance the technology and communications infrastructure in the oil and gas industry.</p> <p>WO7- Developing precise tax and customs policies in the oil and gas industry to improve the efficiency of the economic system.</p>
<b>Threats (T)</b>	<p>Strength*Threat Strategies</p> <p>ST1- Developing special and general stock allocation strategies for stakeholders of the oil and gas industries. Establishing economic and social justice to address investment challenges and resolve security problems.</p> <p>ST2- Applying the oil and gas industry and environmental diplomacy to improve regional and international relations and eliminate regional bans and threats.</p> <p>ST3- Establishment of the principles of democracy, civil and political rights and social justice to resolve cultural and social problems. Use of the principles of diplomacy, international image, traditional, cultural and religious interactions in the direction of detente and the removal of political barriers between the Kurdistan Region Government and the federal government.</p> <p>ST4- Codification of extremely flexible strategies to reduce vulnerability from price instability in international oil and gas markets.</p> <p>ST5- Promoting the technology and communications infrastructure to establish coordination among governmental organs at different levels.</p>	<p>Weaknesses*Threat Strategies</p> <p>WT1- Development of downstream industries in refineries and petrochemicals to meet domestic needs and export of oil and gas products and adjust internal supply and demand.</p> <p>WT2- Planning and policymaking of energy resources development to achieve energy security and reduce dependence.</p> <p>WT3- Establishing appropriate economic and business relations with neighboring countries to transfer oil and gas resources to global markets.</p> <p>WT4- Formulation and approval of the legal frameworks (laws, regulations, guidelines) by applying international law and developing national environmental laws to eliminate the existing legal gap.</p> <p>WT5- Developing strategy and transparency control in finance and contracts to cope with corruption in the oil and gas industry.</p> <p>T6- Developing a strategic management and environmental macro policymaking program at various levels of education, culture and society to confront financial and administrative corruption.</p>

The environmental policy strategy in the oil and gas industry for sustainable development has been in a competitive position in accordance with the above diagram. This means that the environment is

unstable and financially weak, as well as highly tensional and competitively strong. The essential point of the strategy in this section is to gain financial strengths to compensate the instability of the

environment to take aggressive strategies from now on. A competitive strategy approach is suggested when the industry has got good points in the areas of Industrial strength (IS) competitive advantage (CA) SPACE matrix but has failed in financial strength (FS) and environmental stability (ES) (Rows et al., 1982).

Integrating strategic factors together with the formulation and presentation of specific strategies for environmental policy in the oil and gas industry. After identifying external and internal factors, the factors were evaluated. At this stage, key and effective factors were identified and the strategies were proposed and selected (Fred & Forest, 2016). This was done using the "Opportunities, Threats, Strengths and Weaknesses Matrix" which can be called Strategic Factors Matrix. In implementing this matrix, after listing each of the four strategic factors, the strategies are derived from the intersection of each of them (Yüksel & Dağdeviren, 2007).

Due to the large number of strategies provided, all Selected Environmental strategies in the oil and gas industries of the Kurdistan Region were presented in fifteen categories called the Fifteen Strategies. The Fifteen Strategies are:

S1. Reforming the tax structure and providing more facilities for foreign companies and attracting other companies.

S2. The use of the embassy and consulate of various countries in the Kurdistan region to promote democracy and civil and political rights.

S3. The use of the activities of human rights organizations and international transparency in the direction of social justice and the establishment of the principles of democracy.

S4. Teaching and training specialized human resources (the young population) and their application in establishing coherent management and development of the oil and gas industry to meet the

domestic needs and export of oil and gas products.

S5. Financial supportive policies in the oil and gas industries to increase the professional and specialized human resource as well as the efficiency of domestic and foreign private companies.

S6. Planning the development, approval and establishment of a health, safety and environment management system in the oil and gas industries.

S7. Development and establishment of a strategic plan for recognition and development of energy resources (renewable and nonrenewable energies) to ensure the security of domestic energy supply (in light of fluctuations in oil and gas markets) and meet the energy needs in the world.

S8. The use of the oil and gas industry and environmental diplomacy to improve regional and international relations and eliminate regional bans and threats.

S9. The use of the principles of diplomacy, international image, traditional, cultural and religious interactions in the direction of detente and the removal of political barriers between the Kurdistan Region Government and the federal government.

S10. Development of research infrastructures and the use of external facilities to create and improve the communications and technology infrastructure in the development of the oil and gas industry, and to solve environmental and sociocultural issues.

S11. The establishment of the principles of democracy, civil and political rights and social justice through the use of domestic and international communication and media infrastructures to resolve cultural and social problems.

S12. Planning and policy development of energy resources to achieve energy security and reduce dependence.

S13. Planning and approval of the legal framework (laws, regulations, guidelines) by applying international law and

developing national environmental laws to eliminate existing legal gaps.

S14. Developing macro policymaking and transparency control through the application of human rights and international organizations in finance and contracts to confront and deal with corruption.

S15. The use of international financial support, precise tax and customs policies, the establishment of appropriate economic and business relations with neighboring countries, the supervision of NGOs, and stakeholder stock allocation strategies for economic development and financial system efficiency. Then, using FDEMATEL, the cause and effect graph of the components was determined.

Decision-making Trial and Evaluation Laboratory (DEMATEL) was designed by the Battele Memorial Institute between 1972 and 1976 to investigate and solve complex problems(Shieh et al., 2010). This technique helps to build a structural model and embody the model's relation by providing a cause and effect

diagram(Fontela & Gabus, 1976). Given the ambiguity and uncertainty of decision makers' judgment to compare elements, fuzzy logic can be used (Wu, 2012). Fuzzy logic was first introduced in 1965 by Professor Lotfizadeh. Essentially, this technique is based on the theory of graph, which allows the investigation and description of problems to be embodied (Lin, 2013).

To examine the criteria, the opinions experts were used and the calculation of mean paired comparison, normalization, as well as the preparation of the relationship matrix were done using the fuzzy method. Finally, the significance of the indicators was determined using these formulas ( $D_i + R_i$ ) and the effectiveness of criteria ( $D_i - R_i$ ). If  $D_i - R_i > 0$ , the relevant criterion will be effective, and if  $D_i - R_i < 0$ , the criterion will be impressible. As shown in table 1-4, the significance and effectiveness of components have been shown 4.

Table 4. The significance and effectiveness of criteria (fuzzy and crisp numbers)

Components	$\bar{D}_i + \bar{R}_i$	$\bar{D}_i - \bar{R}_i$	$(D_i + R_i)_{def}$	$(D_i - R_i)_{def}$
Political	(3.07,3.22,9.11)	(-3.43,0.00,5.02)	5.13	1.59
Economic	(3.00,3.09,9.00)	(-3.86,0.00,4.64)	5.02	0.78
Socio Cultural	(2.79,3.00,8.70)	(-4.32,0.00,4.32)	4.83	0.00
Technology	(2.20,3.12,8.55)	(-4.91, -0.08,4.22)	4.62	-0.61
Environment	(2.50,3.26,8.53)	(-5.38,0.08,4.60)	4.76	-0.70
Legal	(2.70,3.39,8.59)	(-5.47,0.00,4.48)	4.89	-0.99

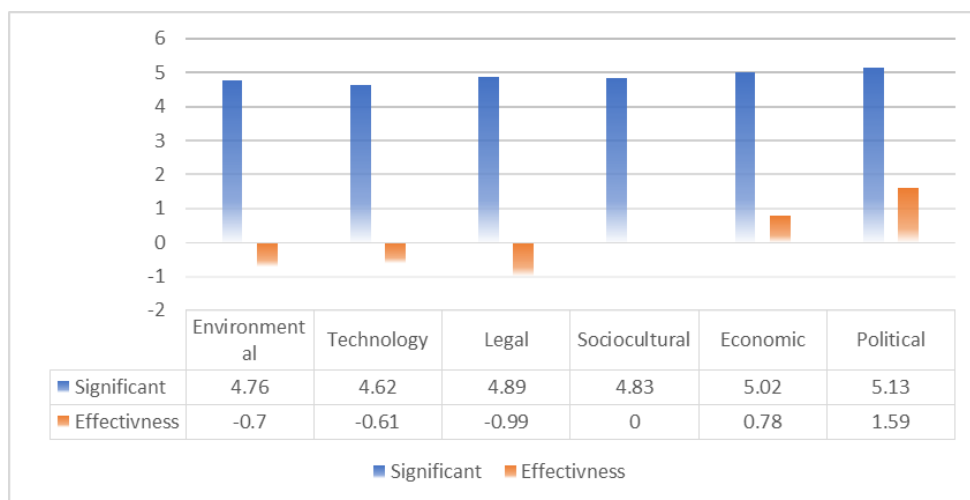


Fig. 8. Final results of the significance and effectiveness of components on decision

To prioritize them, the fuzzy analytic network process (FANP) was used. To achieve the research goal, paired comparison questionnaires were designed and distributed among the experts. Using modified method Semih et al (Önüt et al., 2009), the paired comparison tables were performed and the weights of the components were obtained and prioritized accordingly. Gogus and Boucher’s method was used to calculate the compatibility. The final weighted criteria matrix for the environmental policy of the oil and gas industries was obtained as shown in table 5.

According to the fifteen options strategy derived from the analysis of the SWOT matrix, the options are prioritized for the oil and gas industries in the Kurdistan region. The results indicated that the A15 and A14 strategies have been prioritized with scores of 0.143 and 0.120. Also, the A4 and A2 strategies with the lowest scores of 0.66 and 0.05 were placed in the last ranks. This

shows that we have more basic problems and that we should address these problems in the first place, especially political and economic problems that have been more important and effective in the oil and gas industries. As shown in table 6 and figure 9.

According to Table 6, the political criterion with the weight of 0.292 has the highest impact on the current environmental policy design in the oil and gas industry, and then the economic criterion with the weight of 0.264 is in the second place. The results show that the technological and socio-cultural criteria with weights of 0.139 and 0.122 have been at the lowest places in terms of effectiveness. The results are consistent with the current status, since the environmental policy of the oil and gas industries has been influenced by political and economic criteria from various dimensions.

Final weights of strategies for oil and gas as shown in below figure 10.

**Table 5. Final weighted criteria matrix for the environmental policy**

Row	options	Strategies fuzzy ultimate weight	The definitive weight of strategies	Prioritization based on definite weight
1	S15	(0.021,0.109,0.403)	0.143	1
2	S14	(0.019,0.094,0.366)	0.120	2
3	S12	(0.017,0.085,0.335)	0.116	3
4	S13	(0.017,0.083,0.34)	0.115	4
5	S8	(0.015,0.072,0.294)	0.099	5
6	S7	(0.014,0.068,0.287)	0.096	6
7	S11	(0.014,0.066,0.278)	0.093	7
8	S9	(0.013,0.064,0.276)	0.091	8
9	S10	(0.013,0.062,0.271)	0.089	9
10	S6	(0.013,0.059,0.256)	0.084	10
11	S1	(0.012,0.059,0.24)	0.082	11
12	S5	(0.011,0.05,0.23)	0.073	12
13	S3	(0.011,0.05,0.221)	0.072	13
14	S4	(0.01,0.045,0.207)	0.066	14
15	S2	(0.008,0.033,0.159)	0.05	15

**Table 6. The final weighted criterias matrix for the environmental policy of the oil and gas Industries**

Row	Components	Final fuzzy weight	Definitive final weight
1	Political	(0.111,0.28,0.525)	0.292
2	Economic	(0.09,0.248,0.504)	0.264
3	Legal	(0.051,0.126,0.339)	0.149
4	Environment	(0.052,0.124,0.333)	0.147
5	Technology	(0.05,0.119,0.308)	0.139
6	Sociocultural	(0.04,0.102,0.279)	0.122

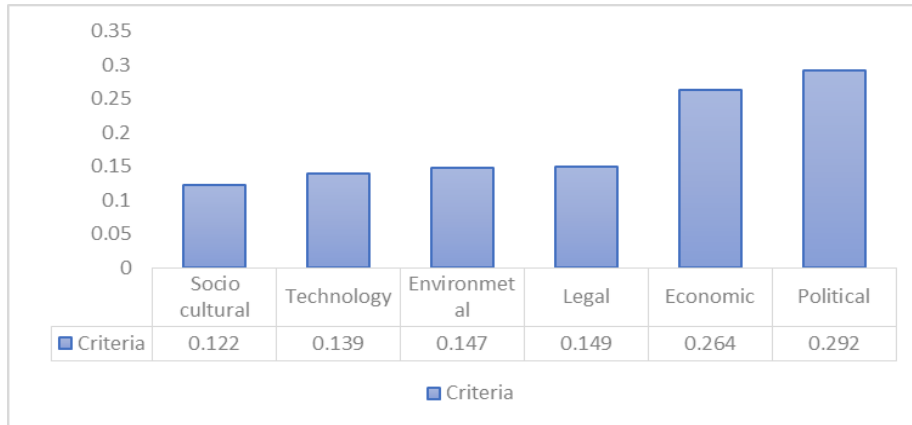


Fig. 9. Final weights of the criteria for oil and gas



Fig. 10. Final weights of options (strategies) for oil and gas.

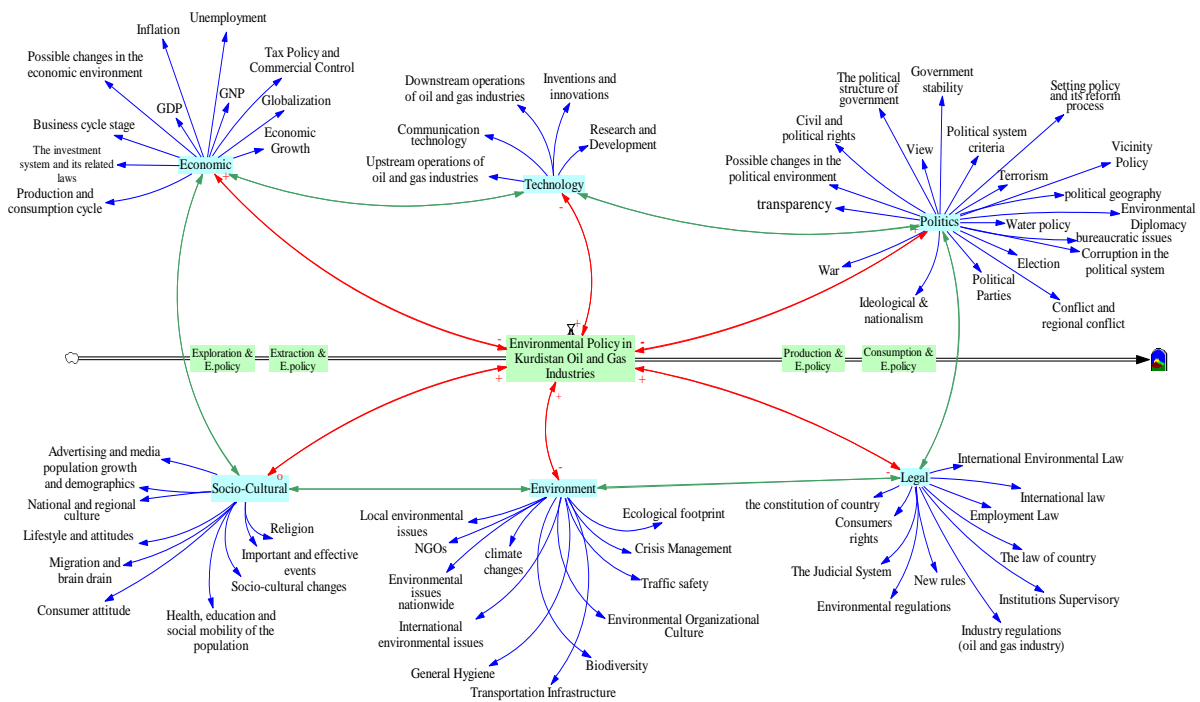


Fig. 11. Structure of components and their relations generated in Vensim

The system dynamics approach is a method for analysis, problem solving and system simulation (Barlas, 2009). This technique is a method for analyzing systems and the complex problem with the help of computer simulation (Alessi, 2000). The system dynamics approach was developed in the 1960s by J. Forrester at the University of MIT (Forrester & Forrester, 1971; Forrester, 1997).

In the above figure, we have tried to simulate the adequate parameters and their relationships according to the results of the research. In spite of the importance of all the parameters for efficient environmental policy, in terms of the impact of both the political and economic parameters, the sociocultural, environmental, legal, and technological criteria have been negatively affected. In the region of Kurdistan, a holistic view of environmental policy and the development of oil and gas industries in terms of sustainable development along with environmental standards are crucial for the improvement of ecological conditions, economic progress and the sustainability of the policy of human and physical centering.

## **RESULTS AND DISCUSSION**

According to the results of the DIMATEL fuzzy diagram, we will conclude that among political, economic, sociocultural, technological, legal and environmental components, the political and economic components are in the positive area of both axes, which are known as a causal factor relationship regarding relation type and with high effectiveness and importance in terms of intensity. This is due to the political and economic system because the political system in the Kurdistan region and Iraq is heavily dependent on the oil and gas industries, and economically, the oil and gas industries are the only financial backbone for the economy of the country. The significance and effectiveness of the policy and economy play a vital role in the

oil and gas industries and both are the most effective in the development of environmental policies in the oil and gas industries.

The result of the sociocultural component also indicates that the sociocultural component is of great importance, but its effectiveness in the oil and gas industry is completely ineffective and has no role whatsoever. On the one hand, its reason may be due to political system control and a big gap between the Kurdistan society and its political system. On the other hand, the society still has not directed the political system to the transparency and explanation of the principles of liberalism democracy due to the deep cultural problems and the lack of environmental awareness of its influencing ways and effectiveness on the country's economic resources, especially the oil and gas industries.

Also, despite the importance of the components of technology and environment, the two components are mostly affected by political and economic components because the political system has many problems with the environmental standards, from the cultural point of view because the Kurdistan region is at the beginning of the creation of an independent economy. At the same time, environmental issues are not highlighted in the oil and gas industries, which is one of the biggest challenges facing developing countries, including the Kurdistan region where there are many problems and barriers to economic development and environmental protection.

Regarding environmental, technological and legal components, they are very important and are influenced by the political and economic components in shaping the development of the oil and gas industries. There are many reasons to prove this result with the reality of oil and gas industries and issues related to environmental policy in the Kurdistan region. Some of them are as follows:

- In most political systems in the Middle East, especially in the Kurdistan region and in Iraq, among the individual greed, and regional and international pressures, efforts have failed to establish macro-policymaking and strategy management systems. Hence, it is difficult to determine their effectiveness level and to find the joint points of economic development and sustainable development.

- The weakness of the law, the inefficient bureaucratic system, and the barriers faced by the regulatory authorities have, on the one hand, led to the ineffectiveness of efforts in the oil and gas industries, and, on the other hand, they have prevented the country from creating a proper tax and customs system. One of the most important challenges between the Kurdistan region and Iraq is the lack of a law that would eliminate disparities and tensions related to the oil resources that they share and preserve the political and civil rights.

- Technology has been influenced by policy and economy, and it is critical that the development of technology in the upstream and downstream sectors of the oil and gas industries of the Kurdistan region remain compatible with the environmental standards. In this context, one must avoid political decisions, and a purely economic approach and a coherent and efficient management system is used to achieve the energy security. The political system in Kurdistan region has failed to benefit from regional and international changes and the advancement of countries that have acted well in the field of environmental management and policymaking in the oil and gas industries. Thus, the Government were not able to use the equations in support of the political system and the preservation of capital for the future of the Kurdistan region and for future generations.

After the major oil and gas companies started investing in the world, the

Kurdistan region experienced rapid development, but barriers such as the lack of a modern financial and economic system, poor management, and lack of specialized manpower and other sub-components made different governmental dimensions not be taken as expected.

An advanced economy will not occur in the Kurdistan region unless attention is given to sociocultural, environmental, technological and legal issues. The current economic system in the Kurdistan region has controlled its balanced and effective relations with other aspects for sustainable development rather than protect them, which is why other components are under the great influence of political and economic issues and have moved backward instead of being progressed.

The sociocultural component has been used to formulate the environmental policy of the oil and gas industries and has no contribution to it. The reason for this is that the Kurdistan society is not aware of this section in terms of cultural aspects and how it should manage its rights, so it cannot play its role as a dynamic society in the formulation of environmental policymaking and in the development of oil and gas industries. Therefore, the gap between the state and society is reduced and the political system is improved to protect the country's interests and economic development, and take steps to support the environment. In general, the political and economic system is derived from society, and the dynamic society will generate a dynamic political and economic system. The opposite of this too is true.

The legal component in the formulation of environmental policies in the oil and gas industries is very significant and effective. Generally, in the Middle East, and especially in the Kurdistan region and in Iraq, there are many weaknesses associated with law and regulation; the proper power that can support their enforcement is limited and has little influence. Despite the fact that

the law and regulations are important for the conclusion of contracts, production launching and extraction, their effectiveness is critical. As shown in the diagram, the issue of law has been influenced by the political and economic component. This is a major obstacle to environmental policy and no step can be taken in direction of the sustainable development.

The environmental component mentioned in the chart, and the role of the environmental component in formulating policy and development of oil and gas industries have been considered to be important, but the environmental component is highly influenced by political decisions and economic development. The severe need for economic progress has resulted in a disregard for environmental issues. Generally, industries, especially the oil and gas industries, have caused serious environmental damage, including global warming, climate change and the elimination of biodiversity. They also have created various contaminants that have affected the environment and the human community. As we observe, the technology component is at a remote horizontal point relative to the origin of coordinates, which indicates the high importance of this component in the formulation of environmental policies related to the oil and gas industries. It also has a high level of impressibility. Considering the barriers and problems of technology in both upstream and downstream areas, it can be said that the importance of this component has been well-clarified in the formulation of environmental policy in the oil and gas industries. But due to political decisions and economic difficulties, this component has been affected and has faced major obstacles to meet the domestic demand for oil and gas and their exports, including infrastructure and communication problems.

## **CONCLUSION**

The oil and gas industries, despite bringing

a lot of capital into the Kurdistan region, which has led to economic growth and development, have increased the fixed costs of services and goods, as well as the destruction of the environment. Therefore, effective and macro policies should be implemented in the area of integrated monetary and service management in the oil and gas industries in terms of the sustainable development and environmental protection, to prevent the transformation of oil resources into disasters. This paper examines Kurdistan's oil and gas industries using PESTLE, SWOT, SPACE, FANP and FDEMATEL techniques to formulate a conceptual model of environmental policy to achieve the goals of sustainable development. As well as identifying and evaluating the influential factors in this field, including political, economic, sociocultural, legal, technological and environmental factors, their sub-components (numbering 68 (as mentioned above)) were also identified. It was observed that the environmental policy of the oil and gas industries in the Kurdistan region has been in the conservative strategies sector (dominance of the opportunities on threats, and weaknesses on strengths). The result of the position evaluation and strategic action determination is also in a competitive position. This means that the environment is unstable, financially poor, as well as industrially tensional and highly competitive. The essential strategy in this section is to gain financial strengths to compensate for environmental instability so that aggressive strategies can be taken from now on. Then, FDEMATEL was used to identify the importance and impact of the components. The two political and economic components play an essential role in shaping the environmental policy and the oil and gas industries, and they are of great importance. In addition to the importance of the sociocultural component, this component has no role in the formulation of



policies and has been influenced. The legal component is also important and effective. Regarding the environmental component, it is considered vital but heavily influenced by political positions and economic development. Finally, the component of the technology is in the remote horizontal point from the source of the coordinates, which indicates the high importance and high level of effectiveness. As a result, using FANP, the fifteen strategic options were prioritized so that reducing costs, improving productivity, and raising capital to follow opportunities and competitive strengths become the goals of the strategies. In some of the articles that come in the background of the research especially those that belong to Iraq and Kurdistan (such as; Dargin, 2009; Gray, 2012; A. Wahab, 2015; Al Saleem, 2015 & etc), they have not seen the environment or paid much attention to it. but in present paper Environmental perspective is used to provide a strategic analysis and a conceptual model in order to evaluate oil and gas industries in line with solving or decreasing Environmental problems.

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