Integrated Management System in Petroleum Companies as a Tool to Achieve Sustainable Development –Evidence from ENAFOR, Algeria-

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Summary: The purpose of this study is to highlight the importance of the integrated management system (quality, environment, health and security) in achieving sustainable development in petroleum companies; it will focus on the case study of Algeria specifically ENAFOR. The present study relies on the descriptive and analytical approach as well as the historical method. It concluded that the implementation of this system has become a crucial necessity for such companies to achieve sustainable development in the light of energy in today's world crisis. As for Algerian National Drilling Company ENAFOR, it has stridden up in this area and has achieved considerable results in terms of cutting back the number of accidents, protecting the environment and achieving customers' satisfaction.

Keywords: Petroleum companies, Integrated Management System, Sustainable development, ENAFOR.
Jel Classification Codes : J28, L15, L71, Q01

I. Introduction :

The energy crisis that the world encounters today appears through the decline in oil prices, environmental problems caused by oil and gas industry, as well as the problem of resource depletion that the public and private are aware of. Thus, the competition has become greater among oil companies to access global markets and to keep their share in the domestic markets, all through the sustainable development in its three dimensions: economic, social and environmental.

For this reason, petroleum companies endeavor to achieve sustainable development through one of the basic tools, which is the adoption of a quality management system, an environmental management system, and a security management system. This helps in gaining customers' confidence, ensuring safety and security at work, and protecting the environment, particularly due to the appearance of environmental awareness in recent years as a result of aggravating environmental problems of which some are extended from the local level to become a global problem threatening the plane. With the passage of time, companies discovered that these systems have to be integrated as the separate execution of any of them is a waste of effort, time and money. Therefore, they combined them to form an integrated management system (IMS), which includes all of the quality management system, environment management system, security management system, represented by standard specifications ISO9001, ISO140001, OHSAS18001. The implementation of this system by the companies is through creating a feature within the organization that includes both Quality, Environment and Security, called QHSE where: Q (Quality) - H (Health) - S (Safety) - E (Environment).

Algeria is one of the leading oil and gas industry countries because of the large potential of fossil resources as there are many companies that are active in this area, including Algerian National Drilling Company ENAFOR, which has made great strides in the field of sustainable

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development through the integrated system management application (quality, environment, security).

I.1. Research Problem:

Through this study, we attempt answering the following question: What is the contribution of the integrated management system in achieving sustainable development in the petroleum companies? What is the status of the Algerian National Drilling Company ENAFOR in this area?

I.2. The study' purpose:

The importance of this study stems from itself because it is one of the important and modern topics in light of the challenges that petroleum companies face, especially the environmental ones. It sheds light on one of the most important methods developed to achieve sustainable development in companies, including petroleum, represented in the integrated management system, which combines achieving quality in products, protecting the environment and achieving security within the company. The importance of this study also stems from the fact that it focuses on the petroleum companies in Algeria with a focus on the National drilling company, being one of the oldest petroleum companies that adopted this system at the global level.

I.3. Previous Studies:

The most important studies related to our study available to us are as follows:

1. The study of Sarafrazi & Al, titled ***'Diagnosis Integrated Management System (IMS) and ways to improve the refinery in Abadan using TOPSIS'***[1] This study identifies events and integrated management system challenges in Abadan oil refining company and presents suitable solutions for their promotion. It did interviews with company experts to prepare a questionnaire. At the end, four basic strategies were defined and suggested for better performance. This study enabled us to understand the integrated management system in refineries, yet our study focused on all petroleum companies especially in Algeria, and it relied on description and analysis in ENAFOR which is a petroleum company of drilling.
2. The study of Redjem Khaled, Mansouri Houari, Metsaha Nassima titled ***'The impact of the health and safety system on the level of work accidents- Case study of the National Drilling Company-Algeria'*** (written in Arabic)[2]. The researchers aimed to evaluate the effectiveness of health and safety system in reducing work accidents, their study relied upon an interview with the head of health and safety department and the questionnaire tool. The study figure out that there is a commitment of the administration to develop, monitor and implement safety programs, despite the fluctuation occurred in some years. This study is similar to ours in the case study; however, our study based on the IMS/QHSE not only on HSE. Moreover, we studied the effect of the implementation of this integrated system to achieve sustainable development, yet the previous study focused on the he impact of health and safety system on the level of work accidents.

II. The effect of oil activities on both environment and safety in Algeria:

II-1- Waste generated by petroleum companies in Algeria:

The amount of waste generated annually by the structures of Sonatrach group is estimated to be at about 225000 t/yr. Table 1 illustrates the distribution of waste by major base categories.

It should be noted that the quantities presented exclude the following two categories of waste:

- Waters mixed with hydrocarbons from water-hydrocarbon separators: they are generally not treated as waste but as wastewater and are often treated on-site;

Drilling material containing hydrocarbons: they are the subject of separate management, generally at the site of their production, their quantities are estimated to be more than 200000 t/yr[3].

II-2- Contribution of petroleum companies in climate change in Algeria:

Producers of natural gas, coal, oil or cement are the most polluting companies for the planet. Global fossil fuel and cement emissions since 1751 total 1,574 Gt CO_2, of which the 103 Carbon Major entities account for 69.8% over the full global history from 1751 to 2017. Disaggregating for each fuel, Carbon Majors account for 79% of global emissions from crude oil & natural gas liquefied, 71% of natural gas, 62% of coal, 60% of cement, and 51% of flaring[4].

The top 5 are the five most polluting companies in 2017 are: Saudi Aramco (4.38%), the American Chevron (3.20%), Gazprom (3.19%), ExxonMobil (3.09%), and the National Iranian Oil Co (2.63%). In the first 20, there is an Algerian company: Sonatrach ranked 18th with 0.91% of total emissions. (Figure 1).

The top 20 companies have collectively produced 480 milliard tonnes of carbon dioxide and methane since 1965 -35% of all fossil fuel emissions worldwide at that time. The worst offenders in the top 10 include Saudi Aramco (number one), Chevron, ExxonMobil, BP and Royal Dutch Shell.

Seven-eighths of emissions attributed to the top 20 carbon producers is from the use of their products – petrol, jet fuel, natural gas and coal – and one-eighth from extracting, refining and delivering finished fuels[5]. These carbon fuels are produced and marketed to consumers with the knowledge that they will worsen the climate crisis[6].

In Algeria, the emitted CO_2 is released directly into the atmosphere. Only 1% of this gas was geologically sequestered until 2011. The only known site of the geological sequestration of CO_2, until the cessation of this activity in June 2011, is that of Krechba near the gas site of In Salah.

II-3- Petroleum industry risks in Algeria:

The oil industry --at its different stages-- is exposed to the possibility of some accidents that may cause environmental catastrophes like fires in oil wells, as was the case during the Gulf war. Furthermore, there are incidents of tanker sinking and collision with coral reefs such as those occurring in the Red Sea and the Gulf of Aqaba, or the explosion of pipelines transferring oil and its products. Oil spills may also occur because of corrosion in both sea and land pipelines.

In addition, the risk may be the result of the use of certain chemicals in the oil industry at all stages due to their lack of proper storage, leakage or ignition, which will have profound effects on the environment components.

The risks are classified in three categories depending on the origin and the characteristics of the nuisance: the industrial risks that are at the origin of the so-called major accidents; Professional risks, which give rise to work accidents and occupational diseases; finally, the risks of everyday life such as domestic risks.

III. Presentation of the integrated management system (IMS) in petroleum companies:

III-1- Definition of the IMS:

Standardization is a significant element of society today and standards are used in more and more areas. The most commonly known management standards ISO 14001 (environmental management) and ISO 9001 (quality management) are adjusted to function together. The trend is that for each new version, these standards become more and more similar. In the new version of standard for quality management ISO 9001/2000, some demands are increased or changed. The most significant change is the input of target-orientated management, which means that the line of production is in focus rather than each department working separately. In recent years, a number of new standards have arrived, with the focus on working environment and social responsibility. Among these are OHSAS 18001, which is a standard for the working environment that is already in use. It is based on ISO 14001 and has been developed to work well with ISO 9001 and ISO 14001. Social Accountability 8000 (SA 8000) and Account Ability 1000 (AA1000/2000) are more general standards with social and ethical issues in focus[7].

The main factor of the emergence of the thought of triple integrated management systems is joint funds between job safety and health standards (OHSAS18001), quality management system (ISO 9001 and ISO/TS 29001), Environmental management system (ISO 14001) and coordination of existing systems and the lack of overlap between them. The similarity of this management system and the advantages of the concurrent offered implementation of integrated management systems which is a new solution to coordinate between the various parts involved and prevent disconnection activities[8].

Accordingly, the IMS is a management system that integrates all components of a business into one coherent system to enable the achievement of its purpose and mission. It is also a management system that integrates all of an organization's systems and processes into one complete framework enabling an organization to work as a single unit with unified objectives[9]. Table 2 presents the fundamental concepts related to each standard.

III-2- Common challenges of the IMS:

The challenges of an integrated system are[10]:

- **Quality:** Customer retention, competitive advantages creation, be more competitive, save money.
- **Safety and Health:** Avoid criminal and administrative sanctions reassure, prevent the consequences of accidents (image, financial), and retain its staff.

- **Environment:** Reassure a 'citizen' commitment, avoid criminal and administrative sanction s, and prevent the risk of losses due to accidents, save money, save resources.

The main factor that consolidates the formation of the above integration management systems trilogy was the similarities and the common points existing between these systems. We state these items briefly[11]:

- All three systems on general viewpoint and approach system classification are put in a chain with management systems. This is seen also from these systems' name.
- Planning: Determining the objectives and necessary processes to achieve results in accordance with the policy.
- Implementation: the implementing processes.
- Review: monitoring and measurement of processes associated with the policy, macro and micro objectives, legal requirements and other requirements and reporting.
- Action: corrective measures were required for continuous improvement in the performance of the integrated management system.

In brief, some benefits of this integrated management systems include[12]:

- The definition of the aim clearly in regard to the organization policy;
- Prevent wrong movements to the extracted routes in taking aim;
- Eliminate the interference, imbalance and different works within the system;
- Decrease of rework cost;
- Creation and expansion of information systems in dynamic workflow;
- Providing revision possibility in system and fix defects and weaknesses;
- Establishing the possibility of getting feedback from the activity details;
- Providing background for various forecasting process;
- Reducing documentation volume and records system.

III-3- Petroleum Companies' Approach and Experiences on the Integration of the Management Systems:

There are three best approaches to implement IMS depending on the current situation of the organization. Firstly, conversion, which is used for organizations that only, have QMS, built by adding the necessary processes to cater for HSE and other standard requirements. Secondly, Merging Systems for organizations that have more than one system. Finally, systems engineering approach – design a top down system to achieve a specific objectives, one coherent system which serves as business needs and does not tie the organization to a particular standard. To ensure effective design and implementation of IMS is done, the Company has to define first the Business Model and Primary Functions then analyse business processes using flowcharts, standard and failure mode analysis techniques. In addition, formulate operational policies, which will govern the process and their inter-linkages; develop internal business procedures to control each business process, which define who does what, where, when and how; implement the new and improved practices. If required identify optimum documentation needs by linkage to the control procedures and document the system[13].

III-4- Integrated Management System Model in petroleum Industry:

There were few established IMS models proposed and used by Oil and Gas Companies as published in the literature. The basic IMS Model consists of five major components: Policy, Planning, Implementation and Operation, Checking and Corrective Action and Management Review. The IMS documentation consists of QSE Management Manual, Common Procedure Manual, Environmental Procedure Manuals, Safety Procedure Manual, Operational Control Procedures, Legal Register, Year Planners and Records showing evidence of having complied with the requirements of the standards. The IMS Model must be built around the way work is conducted, and use a standards/process systems approach based on ISO 9000, ISO 14001, and E&P Forum. Moreover, maintain the feel and look of the E&P forum model because the European operations had successfully implemented that system, they were established, and they were experienced. Finally, focus the organization on performance while maintaining compliance[14].

IV. IMS and sustainable development in petroleum companies:

Without going into detail, it is difficult to talk of QSE without talking about sustainable development. The concept was born around the early 1970s. At this time, experts expressed a strong concern: economic development has a negative impact on the environment and could strongly unbalance our ecosystems in the long term and increase human inequality. A definition was given in 1987: "sustainable development meets the needs of present generations without

compromising the ability of future generations to meet their own." (Excerpt from the 1987 Brundtland report - name of the premier Norwegian, rapporteur of the project of the world commission for environment and development)[15].
This concept, developed in 1992 in Rio, aims to reconcile economic, environment and social cohesion.

A company committed in sustainable development will seek a permanent balance between the constraints and issues covered. The challenge is to manage the company so that it is viable, liveable, and fair. This "ideal" company cares to be profitable, to create economic value while imposing a double responsibility at a global level: the ecological preservation of our planet, and the respect for the dignity of the human[16].

The integrated management system, is a practical (concrete) approach to sustainable development "management is not a science, it is a practice", this apothegm of Hervé Sérieyx is true when, operationally, the company seeks to achieve long-term sustainable development strategy and the management of risks on a daily basis. In other words, it must define what tools are used or adapted harmoniously to the expectations of the customer, who is the centre of the concerns of the company, and those of the stakeholders that are both local residents, staff, clients, shareholders, etc[17].

A QSE system is a first step towards sustainable development, the concept combines three good objectives: economic efficiency, social equity and environmental conservation.

The company ensures its competitiveness permanently by creating value, fair and responsible manners to the customer and all other interested parties (including shareholders), by integrating into its aspects quality products, environmental risk management, and social activities that could alter its image and have significant financial consequences.

At the end, we will see that the integrated QSE system has two basic faces: the face "risk control" that reassures and the face "performance improvement" which commits the company to a global approach of sustainable development[18].

Therefore, a petroleum company must be concerned with sustainable development through an integrated management system that includes all aspects: quality, environment, security. In fact, interest in fixtures and equipment used by the company is taking into account the quality of the used cement, pipes, machines…etc. In addition to that, the quality management of all operations, the mention of environmental dimension from the beginning in the company's policy as well as its willingness and preparedness for any emergency such as a fire, for example, in one of the wells by developing emergency response plans. All this will make the company more structured to take into account all aspects at once.

V. The role of IMS in achieving sustainable development in ENAFOR:

V-1- An overview of ENAFOR activities:

It is one of the first oil drilling and services of oil companies in Algeria as well as Africa. In 1966, ENAFOR was created under the name "ALFOR", in the framework of the Plan of development of SONATRACH, as a joint venture between SONATRACH (with 51% of the shares) and the SEDCO USA (South Eastern Drilling Company, Dallas) (with 49% of the shares).

In 1981, SONATRACH put an end to its partnership with SEDCO by establishing the National Drilling Company on January 1, 1982, by the Ministerial Order of December 31, 1981,
bearing the date of substitution of ENAFOR for SONATRACH in part of its skills.

In 1989, ENAFOR became an independent company in the form of SPA, whose social capital, 20.000.000 AD, is held by the Mines fund at 40%, chemical/petrochemical/pharmacy fund at 30% and the food fund at 30%.

SONATRACH, through the holding company SSP[19], became the main shareholder of the company in 1998, with 51% of the shares to its credit. The Holding RGT[20] holds 49%.

The year 2005 marks the integration of ENAFOR in Sonatrach group, which then becomes the 100% subsidiary of SONATRACH[21].

With its capital experience of over 45 years in the field of oil drilling, ENAFOR excelled in its field which is today an unquestionable reputation on the national and international level. Operating on behalf of SONATRACH and its foreign economic operators, ENAFOR concentrates its operational hub on the two main activities, which are drilling and Work-Over (in addition to the Maintenance oil activity and support such as Transport and hospitality activities).

ENAFOR is a member of the International Association of Drilling Contractors "I.A.D.C".

ENAFOR engages with professional partners belonging to the different countries of the world for the purpose of opening up to the international market.

Here is a list of few companies which have already signed a partnership contract with ENAFOR : BRITISH PETROLEUM, TOTAL, BHP, MOBIL, REPSOL, SONARCO, ANADARKO, BURLINGTON RESOURCES, SINOPEC, AMERADA HESS, GTFT, FIRST CALGARY PETROLEUM, STATOIL, SCHLUMBERGER, MEDEX,... etc.

V-2- ENAFOR certification of QHSE:

ENAFOR missions are listed as part of the overall strategy of the SONATRACH group: participate actively in the development and the reconstruction of the energy reserves for current and future generations.

As part of its policy of modernization and development, ENAFOR has set ambitious goals, whose purpose is sustainability and the sustainable development of the company. To conform to international standards in its activities, ENAFOR has certified its Integrated Management System (MS/QSE).

After the certification of its system of quality management on January 13, 2004, in accordance with the standard ISO 9001-2000 and certification of its environmental management system according to the standard 14001-2004 on December 06, 2005, ENAFOR got its triple certification quality, health, safety and environment (QHSE) management systems on June 06, 2008 [22]. Regular certification and surveillance audits come to reinforce the reliability and continuous improvement of the Integrated Management system put in place by the company.

ENAFOR underwent two monitoring audits of its integrated management system SM/QHSE, which respectively took place in May 2009 and May 2010.

The audit of certification renewal of its integrated management system (SM/QSE), which took place in May 2011, was followed by two surveillance audits held respectively in June 2012 and June 2013[23].

V-3- QHSE policy of ENAFOR:

The commitment of all to a continuous improvement of the Management system of quality, health and safety, environment, in accordance with the standards and international standards ISO 9001-2008, ISO 14001-2004 and OHSAS 18001-2007 is, today, a reality for ENAFOR. The main lines of QHSE policy of ENAFOR, related to the safety and health of employees, the protection and the security of its facilities, as well as the prevention of pollution of the environment are [24]:

- The awareness of the staff of the application of rigorous procedures and instructions of work and safety, accompanied by awareness campaigns allowing the company to continue to save performance on performance.
- The implementation of the STOP method on drilling sites and its deployment at the level of the rest of the structures from 2012.
- Medical surveillance of the workers and the workplace.
- The generalisation of the HSE Passport at the company level to ensure that regulatory periodic visits are made and that appropriate training is provided to workers exposed to occupational risks.
- The implementation of the "Environment" dashboards at the level of each of the operational structures of the company to ensure the follow-up and control (follow-up consumptions, segregation and different waste collection, disposal of waste,...).
- Sanitation, redevelopment and organization of storage areas at the level of the different bases of the company.
- The assessment of the risks associated with workstations (EVRP), initiated by Directorate Central HSE SONATRACH, ENAFOR's appropriate for application to the level of logistical structures and drilling sites.
- The implementation of the new repository work permit of the SONATRACH group, for which ENAFOR has put in place a training plan - education specific to ensure mastery.
- The signature of a framework contract "nutrition project" between ENAFOR and the University of Constantine, on training and assistance in the areas of nutrition, medical information management, as well as the support of the sick.
- Commitment to the national effort to combat smoking by launching a wide campaign on the matter in a professional environment as well as the establishment of a Committee Director of fight anti-smoking ENAFOR and official opening of consultations to help cessation at ENAFOR on 31.05.2013.

V-4- Results of the IMS' implementation in ENAFOR:

As part of its QHSE policy, ENAFOR puts a series of actions in improving the conditions of work, transport and accommodation, as well as support staff and medical means to still get better results.

- Health, medical surveillance of the workers and the working environment by implementing performance indicators are the means of control of the effectiveness of the actions taken.
- Generalization of the HSE passport at the level of the company is one of the ways in which ENAFOR has been to ensure that periodic regulatory visits are provided to workers exposed to the risk.
- The implementation of the STOP method on which drilling sites is at a significant stage of the fact of implementation of a system of appropriate motivation, the rigorous application of the procedures and work instructions and security accompanied by awareness campaigns have allowed the company to continue to record performance on performance.

The table 3 show the positive effect of the integrated management system in ENAFOR. Through this data, we notice a clear decrease in both number of accidents at work and its frequency rate since 2008, date of QSE implementation, despite the fluctuation that occurred in some years. Nevertheless, the QSE had positive effect on the status of security in the studied company.

- The environment and preservation of natural resources appearance being an important part of ENAFOR policies, the company has implemented the dashboard "environment" at the level of each of the operational structures of the company to ensure monitoring and control (consumption monitoring, segregation and collection of the various waste). The assignment, the redevelopment and the organisation of areas of storage at the level of the different bases located at Hassi Messaoud[25].

➢ **Reduction of energy consumption:**

✓ Expansion of the use of low energy lamps;

✓ Introduction of LED lighting at the level of rigs which allows a better lighting and reduced consumption;

➢ **Reduction of the consumption of energy and gas emissions: exhaust of engines on site with CFCS.**

✓ ENAFOR has invested in the acquisition of emission of exhaust gas analyzers to carry out periodic inspections of its power groups on site;

✓ ENAFOR has launched a program of gradual elimination of all equipment operating with CFCS (Chloro-Fluo-Carbon) that is causing the depletion of the ozone layer;

The solutions proposed to reduce the production of pollutants through:

✓ A powerful injection system;

✓ The implementation of an oxidation catalyst;

✓ A system of recycling of exhaust gases;

✓ A particulate filter. It should be noted that less than 1% of the rejected exhaust gases by engine are harmful.

➢ ENAFOR has implemented a program to optimize consumption of oils for engines with a specialized agency. This action will allow the company to reduce the amount of motor oil generated by the garbage of 280 000 litres annually.

➢ The company reinforces its commitment to environmental protection, plans to implement a system of treatment of the cutting and quagmire. The choice of this mode will prevent the contamination of the soil and underground (aquifers) by especially drilling fluids based oils[26].

In brief, the implementation of the IMS and its control and monitoring in ENAFOR clearly reflect on its performance (economic, social and environmental).

VI. Conclusion:

Petroleum companies have sought hard to adopt quality, environment, and security management systems in order to gain the confidence of its customers, ensure workers' security and protect the environment. The latter inspired by the emergence of environmental consciousness in recent years in consequence to environmental problems as some rippling from the local level to a global dilemma threatening the planet. Over time, companies discovered that they must integrate these systems because the implementation of any of them as a separate system is a waste of time, effort and money.

The adoption of this system of management will make the activity of the company harmonious and integrated so that it takes into account all aspects including product quality, environment and safety at work through the adoption of management systems that are built on a set of goals established by the company that are reviewed periodically.

This system has helped to reduce accidents because they are not desirable nor expensive, as reducing them allowed the reduction of cost, hence the attention to quality, environment and security is of great importance to the social and financial level.

ENAFOR is an important example of the petroleum companies that adopted the IMS to fulfil the sustainable development, and it realized great results in this field.

- Appendices:

Table (1): The amount of waste generated annually by the structures of Sonatrach group

	Household and similar waste	Special waste: uncontaminated metals	Special waste: other than metals	Special hazardous waste	Inert waste
Amount of waste (t/yr)	39630 t/an	24764 t/an	6083 t/an	154727 t/an	30 t/an
Proportion %	17%	11%	3%	69%	0.01%

Source: Sonatrach documents, 2012, p. 2

Table (2): Fundamental concepts related to IMS' standard

	Fundamental concepts							
Standard	Focus	Structural concept	Involvement	Approach	Management	Philosophy	Decision-making	Relationship benefit
ISO 9001	Customer	Leadership	People	Process	System	Continuous improvement	Based on evidences	Suppliers and customers
ISO 14001	Society							Society
OHSAS 18001	Employees							Employees

Source: Dominguesa, J., Sampaioa , P., & Arezesa, P. (2014, July 17). Analysis of integrated management systems from various perspectives. Total Quality Management & Business Excellence. doi:10.1080/14783363.2014.931064

Table (3) : QHSE Performances

	2007	2008	2009	2012	2013	2014	2015	2016
accidents at work	108	107	93	53	63	63	68	94
frequency rate	9.68	9.52	8.08	5.05	6.12	6.32	5.27	6.96

Source: prepared by us based on:

- ENAFOR. (s.d.). *Faire du HSE une priorité...* Consulté le July 20, 2020, sur http://www.enafor.dz/perfohse.html

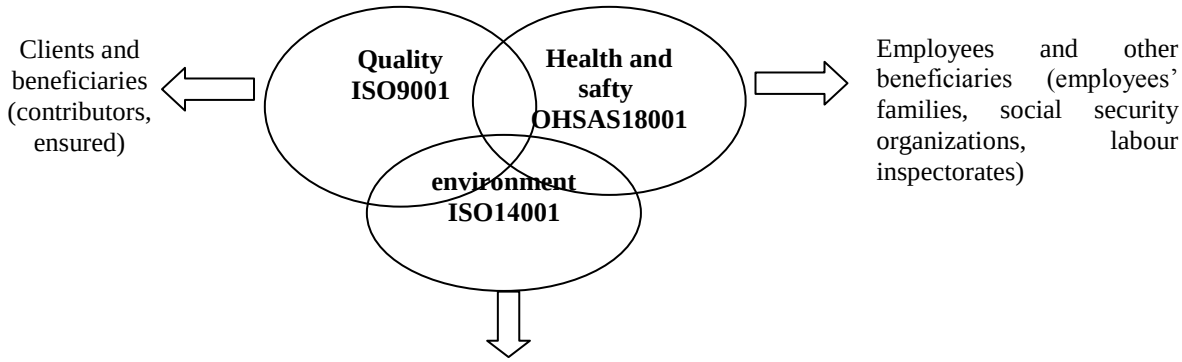
- Redjem, K.& Mansouri, H. & Metsaha, N. (2020). *The impact of the health and safety system on the level of work accidents- Case study of the National Drilling Company-Algeria.* The Journal of the Economic Sciences Institute. University of Algiers 3. 23(1). p.p 91-93. Retrieved July 24, 2020, from https://www.asjp.cerist.dz/en/article/119164 (written in Arabic)

Figure (1): gas emissions of the top 20 petroleum companies (1965-2017)

Entity	$MtCO_2e$	% of global
1. Saudi Aramco, Saudi Arabia	59,262	4.38%
2. Chevron, USA	43,345	3.20%
3. Gazprom, Russia	43,230	3.19%
4. ExxonMobil, USA	41,904	3.09%
5. National Iranian Oil Co.	35,658	2.63%
6. BP, UK	34,015	2.51%
7. Royal Dutch Shell, The Netherlands	31,948	2.36%
8. Coal India, India	23,124	1.71%
9. Pemex, Mexico	22,645	1.67%
10. Petroleos de Venezuela (PDVSA)	15,745	1.16%
11. PetroChina / China Natl Petroleum	15,632	1.15%
12. Peabody Energy, USA	15,385	1.14%
13. ConocoPhillips, USA	15,229	1.12%
14. Abu Dhabi, United Arab Emirates	13,840	1.01%
15. Kuwait Petroleum Corp., Kuwait	13,479	1.00%
16. Iraq National Oil Co., Iraq	12,596	0.93%
17. Total SA, France	12,352	0.91%
18. Sonatrach, Algeria	12,302	0.91%
19. BHP Billiton, Australia	9,802	0.72%
20. Petrobras, Brazil	8,676	0.64%
Top Twenty	480,168	35.45%
Global	1,354,388	100.00%

Source: Climate accountability institute. (2019, October 8). *Carbon majors*. Retrieved July 20, 2020, from https://climateaccountability.org/pdf/TopTwenty%20Rank%201965-2017.png

Figure (2): Common challenges of the IMS



Source: Chambre de commerce d'industrie et de service de la Moselle. (2010). info qualité/sécurité/environnement. (4). France. P 1. Récupéré sur http://www.codlor.com/lettre_qse.php

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[3] Sonatrach. (2012). *Sonatrach document.* Algérie. P 2.

[4]Heede, R. (30 September 2019). *Carbon Majors: Updating activity data, adding entities, & calculating emissions: A Training Manual.* USA: Climate Accountability Institute.

[5]The global polluters list uses company-reported annual production of oil, natural gas, and coal and then calculates how much of the carbon and methane in the produced fuels is emitted to the atmosphere throughout the supply chain, from extraction to end use.

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