THE DR CONGO'S PETROLEUM INDUSTRY: CONFUSION AND MISPERCEPTION OVER THE REAL PHYSICAL DENSITY OF CRUDE OIL PRODUCED IN THE KONGO CENTRAL PROVINCE OF DRC

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ABSTRACT

This paper examines the origin of confusion and misperception clouding the real physical density of crude oil produced in the Kongo Central province of the DRC, known as DR Congo. For many decades, there has been doubt, ambiguity, uncertainty and no accuracy or transparency concerning the real physical/chemical characteristics of crude oil produced in the DRC. Therefore, this paper explores and analyses the characteristics of crude oils produced in other world regions to understand and classify the value of the DRC's produced crude oil, by means of reference to the international standard that define the Gravity (°API) and Sulphur (Wt. %) of crude oil, whether it is light or heavy crude oil. It attempts to bring more evidence of crude oils characteristics that relate to crude oil produced in the DRC since 1973. The objective consists of categorising crude oil produced in the Kongo Central province of the DRC, to determine whether it has been Light Sweet, Light Sour, Medium-Medium Sour, Medium Sour, Heavy Sweet or Heavy Sour. This clarification is very critical in imperative to dissipate the cloud of misinformation and misperception of the property range of crude oil that has been produced consecutively by several multinational oil companies in the DRC since many decades. The PESTIE model or framework was applied to understand the mysterious and ambiguous barriers affecting the entire petroleum industry development in the DRC.

A mixed methods approach was useful to gather different views, opinions and perceptions from qualified stakeholders involved in the DRC's petroleum industry. Both quantitative and qualitative approaches were proficient in revealing often multifaceted of the real value of the DRC's crude oil. The results of this study revealed that the situation of misperception and confusion overshadowing crude oil specifications in the DRC are caused by a complex situation of the business environment uncertainties and instabilities, as well as the vulnerability of the political and socio-economic environments instituted by the colonial economic model (heritage and culture of exploitation and production of natural mineral resources) imposed by a complex system of the global business environment. Results also claimed that much confusion or uncertainties are from opinions, which are lacking accurate information regarding the correct statistical properties of crude oil produced in the country, as well as from the political interferences, frauds, and corruptions, which have been fuelling or influencing opinions about the mass or natural property range of the DRC's produced crude oil. One of the approaches suggested in solving various challenges affecting the DRC's petroleum industry consist of applying the best-practice of the rule of law; the review, monitoring and re-evaluation of policies, regulations, programmes, and strategic plans; transparency system and ensuring the business environment stability in the country. Managing accurately oil and gas activities in the country could be the outcome of less political interference in several socio-economic activities. Thus, it was advised that policymakers and decision-makers have to promote and support the development of research

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institution in line with the natural mineral resources production and processing industry in the country.

Keywords: The Petroleum Industry, Crude Oil Specifications, PESTIE Factors and Political Interferences**.**

INTRODUCTION

Oil and gas production and processing constitute a great source of energy supply and one of the most important springs of socio-economic development and transformation for countries that have public capacity to manage transparently and effectively natural mineral resources that it disposes. Although the socio-economic benefits or role played by the oil industry worldwide, there exist diverse challenges affecting differently countries that produce and refine crude oils. The DRC currently has crude oil potential estimated at up to 20 billion proven barrels reserves and nearly 60 billion cubic meters of dissolved methane in its waters (Titeca & Edmond, 2019). Unfortunately, the DRC's oil and gas industry has been for long affected by various challenges related to the business environment instabilities, as well as to the confusion and misperception over the real physical/chemical properties of crude oil produced in the Kongo Central province. This paper focuses on issues related to the confusion and misperception over the statistical specifications of crude oil produced in the Kongo Central province of the DRC, as well as the political interferences that are negatively impacting the development of the petroleum industry in the country. This paper examines a previously international agreed theory related to crude oil specifications standard (API degree gravity) to classify fittingly the relative density or statistical property of crude oil produced in the Kongo Central province of the DRC.

Theories related to the business environment (PESTIE factors) as well as to the international crude oil specifications were useful to address issues concerning the property range of crude oil produced in the Kongo Central province of the DRC, and to bring more understanding and clarification whether it is Light Sweet, Light Sour, Medium-Medium Sour, Medium Sour, Heavy Sweet or Heavy Sour. The purpose of this paper consists of fixing the opinion of the Congolese community about the veracity of the property range of crude oil, which is produced and totally exported under the label of heavy crude oil since many decades by several multinational oil companies in the DRC since oil and gas field was discovered in 1973. Also, this paper intends to demonstrate the degree of political accountability in terms of clouding the truthful information related to the statistical accuracy of the DRC's crude oil specifications. Unfortunately, limited studies or researchers have been interested in revealing the nature of the black gold being politically and secretly exploited by international oil companies. The option for crude oil to be processed or refined locally has been challenged by various mysterious and ambiguous barriers related to the PESTIE factors.

Thus, this paper begins by drawing the background of crude oil produced in the Kongo Central province of DRC and provides key evidence of the international specifications of crude oil density in order to bring clear understanding upon the DRC's produced crude oil specifications. Important materials discuss and examine the political factor as a major barrier affecting the oil and gas industry development in the DRC. The research methodology, findings and recommendations are provided, intending to explain the critical issue of the characteristics of crude oil produced in the Kongo Central province of the DRC as well as crisis related to the disintegration of the national petroleum industry.

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Background of Crude Oil Exploitation and Production in the DRC

The Democratic Republic of Congo, henceforth DRC, hold considerable crude oil and gas reserves, located mainly in the Kongo Central province, along its Atlantic Ocean Coastline, the Central Basin, the Albertine Graben, and the Tanganyika Graben (IPAD DRC, 2014). Oil and gas exploration in the DRC began since 1960's along the country's 22 km Atlantic Ocean coastline at the estuary of the Congo River, which is sandwiched between the productive offshore producing region of northern Angola and its oil-rich enclave of Cabinda (Mbendi information services, 2015). Furthermore, exploration activities continued during the 1970's and early 1980's and by 1983. Of these, the Mibale field, discovered in 1973 by Chevron (the American multinational Oil and Gas Company), contained 48% of the Coastal Basin's recoverable reserves and has remained the DR Congo's most productive field. The gas field discovered has so far not been exploited. In the DRC, the proven oil reserves in the western province of the Kongo Central have been estimated at approximately 180 million barrels and the DRC's oil production has been limited to 25,000 barrels per day of offshore production, all of which are exported since many decades. However, new oil and gas exploration in the DRC revealed up to 20 billion proven barrels reserves, which align the country second behind Nigeria, which has an estimated up to 37 billion barrels proven reserves and remote above Angola, which has currently around 9 billion proven barrels reserves (Titeca & Edmond, 2019). The estimations of oil and gas discoveries in the Eastern region of the DRC are evaluated at up to 100 000 barrels production per day, once new blocks will move into production phase, which will give the DRC the position of largest crude oil producer in Central and Southern Africa. In addition, along with large recently identified oil fields, the DRC may hold as many as 30 billion cubic meters of methane and natural gas in the three major petroleum deposits.

In the Lake Kivu, bordering Rwanda and Burundi, there is nearly 60 billion cubic meters of dissolved methane in its waters. While the methane gas poses a threat to populations along its shores, this gas can be trapped and converted to electricity. Methane is already being extracted on the Rwandan side of the Lake, through a Rwandan built biogas power plant that is generating 30-40 megawatts of electricity. Beyond the estimated 60 billion cubic meters of methane in Lake Kivu, the lake generates as much as 250,000 cubic meters of methane annually. More crude oil discovery is expected to be revealed in the country, given that exploration activities in the country promised new and great prospect development. But the significant/critical biggest challenge is that since 1960's until today, there persist a strong and resistant political influence in terms of mal-administration and mismanagement of local produced crude oil (no accurate statistics of crude oil produced in the Kongo Central province of the DRC have been published), which is fuelling an unclear/doubt situation or perception over the real physical characteristics of crude oil produced in the country.

Unfortunately, the lack of accuracy/transparency regarding oil and gas activities, the disintegration of the national petroleum industry, as well as the ageing of technological infrastructure of the only one oil refinery industry that the DRC has (SOCIR) are causing many challenges that are affecting and delaying the development process of the entire petroleum industry. The refining sector, which lacks an upgraded and friendly operational oil processing plant, has been identified as a critical challenge amongst many others, which are obstructing the DRC's petroleum industry development process. Unable to process local crude oil, SOCIR has remained non-operational since 1998 until today (Export.Gov, 2017). Furthermore, official statistics in terms of oil production and exportation never reflect an exact reality of activities undertaken in the petroleum industry. Thus, particularly, this paper

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attempts to analyse different views gathered from stakeholders involved in the oil and gas industry of the DRC, in order to understand the specifications of crude oil produced in the Kongo Central province of the DRC.

MATERIALS AND METHODS

Materials

Universal principles classifying the physical properties of crude oils

James (2007) postulated that there are several definitions of petroleum or crude oil, and that crude oil is the essential of petroleum activities worldwide. Nashaat (2013), defined crude oil as a naturally occurring liquid originated in formations in the earth containing of a complex mixture of hydrocarbons of numerous lengths with compound and small quantities of materials such as oxygen, nitrogen, sulphur, salt, and water. Therefore, crude oil, wherever it can be found underground in any world region, may possibly be described as a mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. More than 150 crude grades are treated, and many of these are streams blended from two or more fields (James, 2007). Awadh & Al-Mimar (2015) indicated that crude oil is a complex mixture, which is not a uniform material consisting of up to 200 or more different hydrocarbon organic compounds, where its quality is measured or evaluated based on American Petroleum Institute (API) gravity, Specific Gravity (SG) and Sulphur content (S%). Thus, the word petroleum derives from Latin Petra, meaning rock and Oleum, meaning oil. In addition, the American Association of Petroleum Geologists (AAPG, 2015), described crude oil as a yellow-to-black mixture of gaseous, thick, combustible, solid and liquid hydrocarbons that arises naturally beneath the earth's surface, which can be segregated into elements including fuel, gasoline, kerosene, natural gas, naphtha, paraffin wax, asphalt and lubricating oils and is used as raw material for extensive diversity of derivative products (Kikasu & Govender, 2020).

Oil is ordinarily distinguished from dark black to brown, although it may be even greenish or yellowish but differs critically in appearance, depending on its configuration and where it can be found in its form (Nashaat, 2013). Commonly, crude oil may be well-understood as a liquid combination of hydrocarbons which exist in an appropriate rock layers and can be dug up and processed to produce fuels including diesel oil, petrol, paraffin and other oil or chemical products used as raw materials and energy to support social and economic environment transformation (Kikasu & Govender, 2020). Furthermore, several types of crude oil correspond between two grades: light and heavy crude oils. More details about the grade of crude oils are discussed and clarified further below following the classification range, from the lighter to heavier characteristics of crude oils. Therefore, depending upon the characteristics of the crude stream, it may include small amounts of hydrocarbons that exist in gaseous phase in natural underground reservoirs but are liquid at atmospheric pressure after being recovered from oil well. Crude oil is refined to produce a wide array of petroleum products, including heating oils; gasoline, diesel, and jet fuels; lubricants; asphalt; ethane, propane, and butane; and many other products used for their energy or chemical content (EIA, 2021). James (2007) indicated that there are three hydrocarbon series molecules that dictate the physical and/or chemical properties of crude oil worldwide. These include:

- The gravity
- The sulphur, and

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- The total acid numbers

However, according to James (2007), the gravity, sulphur, and the total acid number are the very important properties that can be used to measure various types of crude oils. Therefore, James (2007) indicated that the description relating to the principles to distinguish crude oils according to their level/grade of gravity, sulphur, and total acid number can be understood as follow:

Gravity

Gravity refers to the measure of the density (mass of crude oil, whether it is light or heavy) of crude oil, which can be described in terms of degrees API (American Petroleum Institute). However, the principle of gravity admits that the higher the API number/degree the lighter the crude oil will be. This implies that crude oils with low carbon, high hydrogen, and high API gravity are usually rich in paraffin and tend to yield greater proportions of gasoline and light petroleum products.

Sulphur content

Sulphur content consists of the undesirable impurity that cause pollution and corrosion concern. Sulphur content is measured following the weight percentage. Crude oils that are containing appreciable quantities of hydrogen sulphur or other reactive sulphur compounds are called sour/heavy crude oils, while crude oils with low carbon are labelled as sweet/light. The ICCT Report (2011) specified that most values of crude oils fall between 10 and 70 API gravity degrees. Jams (2007) postulated that the crossover difference concerning the range of sweet/light and sour/heavy crude oils is fixed generally in between 0.5% and 1.5% ranges/varieties. This may suggest that crude oil with sulphur content ranging between 0.5% and 1.1% can be classify as light/sweet or light sour crude oil, depending on the level of API gravity degrees. In the contrary, crude oil with sulphur content higher than 1.5% can be classified as sour/heavy crude oil.

Total acid number (TAN) of crude oils

Total Acid Number of crude oils is a measure of corrosively potential crude oils. The TAN quantifies the number of milligrams of potassium hydroxide (KOH) needed to neutralise 1g of crude oil. A crude oil with a TAN greater than 1 mg KOH/g is usually considerate corrosive and labelled a TAN crude oil, but corrosion problem can occur with a TAN as low as 0.31 mg. Furthermore, the International Council on Clean Transportation (ICCT Report, 2011) stated that if the API gravity is greater than 10, crude oil can be lighter and floats on water; if less than 10, it is heavier and sinks. However, such as stated earlier, by their physical occurrences/properties, crude oils are classified as light, medium, or heavy, compared to their API gravity degrees. This implies that heavier grades are known as containing a higher proportion of heavier hydrocarbons composed of longer carbons chains (Canadian Fuels Association Report, 2013). Accordingly, heavy crude oils characteristics and availability make them to be cheaper and increasingly plentiful but cost expensive investments to refine since they require significant financial capital and higher processing technology (higher energy inputs and additional processing methods to meet environmental requirements). Furthermore, the lighter crude oil characteristics tend to have a lower sulphur content, which makes them sweeter and different to the heavier crude oils with a higher sulphur content called sour. Thus, the Canadian Fuels Association Report (2013) and ICCT (2011) acknowledged that crude oil is not a homogenous raw material; each crude oil produced in the world has a unique chemical composition, which varies according to the

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manner of its formation (James, 2007). According to Awadh & Al-Mimar (2015), the most important of commercial parameters used to value crude oil quality is the Specific Gravity (SG). Therefore, the low specific gravity indicates good quality of crude oil having lighter fractions and vice versa. However, crude oil is classified as light, medium or heavy, according to its measured API gravity. Awadh & Al-Mimar (2015) postulated the following characteristics of crude oil specifications:

- The API gravity of less than 10 degrees defines bitumen and extra heavy crude oil or asphalt, which on average has an API gravity of 8°, which sink in fresh water, while oil floats.
- The API gravity less than 10° generally is considered as natural bitumen.
- The API gravity from 10° to 22.3° defines heavy oil,
- From 22.3° to 31.1° is considered as medium oil,
- Higher than 31.1° defines the light oil.

This implies that crude oil is classified based on the percentage of sulphur; the S% varies from less than 0.1% to greater than 5%. Crude oils with less than 1% S are called low-sulphur or sweet crude, and those with more than 1% S are called high sulphur or sour crude. But according to Awadh & Al-Mimar (2015), this ratio is not constant, where other studies have considered the sweet oil is that has a sulphur value of 0.5%, while the sour oil is that oil defined by having more than 0.5% S. Moreover, API gravity has been reported to have an inverse relationship with S% of crude oil blends. Therefore, the API gravity varies inversely with both of specific gravity and the S%. Sulphur is relatively a heavier than C and H element; it has 2.07 gm/cm3 density. Thus, it is self-evident that its presence in crude oil causes an increase the specific gravity. This also explains why crude oil with low S% has a low specific gravity and vice versa (Awadh & Al-Mimar, 2015). Therefore, the Specific Gravity of the crude oil is inversely related to the API values and provides a preliminary estimation of the amount of type (heavy or light) of hydrocarbons present (Awadh & Al-Mimar, 2015). This suggests that the lower the Specific Gravity and higher API gravity characterised the high-quality crude oil. Therefore, higher API gravity crude oil has a higher price and is of good quality. The total sulphur content in the crude oil is represented by sulphur compounds such as thiols, sulphides, disulphides and thiophenes, where sour and sweet oil classes are based on S% in the crude oil. It is significant to emphasise that oil classification based on physical characteristics is commercially important (Awadh & Al-Mimar, 2015). Moreover, according to ICCT (2011), the international standard on crudes oil API density varies in terms of classifications, which are indicated in Table 1.

Table 1
CRUDE OIL RANGE/CLASS AND API GRAVITY AND SULPHUR CONTENT (Wt.)

Crude Oil Class		**Property Range**
Gravity	**(°API)**	**Sulphur (Wt. %)**
Light Sweet	35-60	0-0.5
Light Sour: (possibility the DRC's crude oil could be classified between light sweet and light sour or between light sour and Medium-Medium sour: 33.70)	35-60	> 0.5 (DRC, 0.13 < 1.1)
Medium-Medium Sour (DRC's crude oil: 33.70 API)	26-35	0-1.1 (DRC Sulphur: 0.13%)
Medium Sour	26-35	> 1.1
Heavy Sweet	10-26	0-1.1
Heavy Sour	10-26	> 1.1

Source: ICCT (2011)

Table 1 point out that each crude oil is defined by the range of API gravity and range of sulphur content. The terms/concepts light sweet, light sour, medium-medium sour,

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medium sour, heavy sweet, and heavy sour indicate the category/class or variety of these ranges in density/qualitative specifications. Therefore, according to ICCT (2011), crude oil class can be clearly understood as follow:

- The gravity API of Light Sweet crude oil vary between 35 and 60 API degrees, while the property range of Sulphur Wt.% vary from 0% to 0.5%.
- The gravity API of Light Sour crude oil vary from 35 to 60 API degrees with a property range of Sulphur Wt.% that is higher or superior to 0.5%.
- The gravity API of Medium-Medium Sour crude oil varies from 26 to 35 API degrees and the property range of Sulphur Wt. % vary between 0 to 1.1%.
- The gravity API of Medium Sour crude oil vary between 26 to 35 API degrees, while the property range of Sulphur must be higher or superior to 1.1%.
- The gravity API of Heavy Sweet crude oil vary between 10 and 26 API degrees, while the property range of Sulphur WT vary from 0% to lesser than 1.1%.
- The gravity API of Heavy Sour crude oil varies from 10 and 26 API degrees, with the property range of Sulphur WT that is higher than 1.1%.

The understanding of these statistics can help any individual, community, or the population of a certain country and/or producer of crude oil, to classify the physical range or characteristics of crude oil produced in that country. Table 1 illustrates and facilitates the understanding on how to classify physical/chemical properties of crude oil produced in the Kongo Central province of the DRC. In June 2016, a research was conducted to explore the socio-economic role of the petroleum refining industry in the democratic republic of Congo, using the case study of the Congolese Company of Oil Refining Industries (SOCIR). Through this study, the Ministry of Hydrocarbons of the DRC, via the general secretary of the Ministry of hydrocarbons provided to the researcher the statistics aligned to the characteristics or properties of crude oil produced in the country, which is displayed in Table 4 (Specification of the DRC's crudes oil). However, the Department of Hydrocarbons of the DRC indicated that the gravity API of crude oil produced in the country is evaluated at 33.70 degrees API and that the Sulphur Wt.% is evaluated at 0.13%.

Table 2
API GRAVITY AND SULPHUR LEVELS OF SOME WORLD IMPORTANT CRUDE OILS

Crude Oil	Country of Origin	Crude Oil Class Properties		
		Gravity (°API)	Sulphur (wt. %)	
Brent West Texas Intermediate	U.K.	Light Sweet	40.0	0.5
	U.S.A.		39.8	0.3
Arabian Extra Lt. Export	Saudi Arabia	Light Sour	38.1	1.1
Daqing	China	Medium Sour	33.0	0.1
Forcados Export	Nigeria	Medium Sour	29.5	0.2
Arabian Light Export	Saudi Arabia	Medium Sour	34.0	1.9
Kuwait Export Blend	Kuwait		30.9	2.5
Marlim Export	Brazil	Heavy Sweet	20.1	0.7
Cano Limon	Colombia		25.2	0.9
Oriente Export	Ecuador	Heavy Sour	25.0	1.4
Maya Heavy Export	Mexico		21.3	3.4

Source: ICCT (2011)

Already, based on the observation, comparison or similarity of statistics of the density of crude oil produced in the DRC with that from Table 1, it can be attested that crude oil produced in the Kongo Central province of the DRC may be classified in the range between light sweet and Light Sour or Light sour and Medium-Medium Sour crude oil from which,

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the gravity API degree varies between 26 and 35 API degrees gravity and the property range of Sulphur Wt. % varies between 0% to 1.1%. However, the Sulphur Wt. % of crude oil produced in the DRC (0.13%) is lesser or in between 0% and 1.1% Sulphur Wt. %. Thus, the DRC's crude oil has a high API degree gravity (33.70) and very low (0.13 Wt. %) undesirable impurity that cause pollution and corrosion concern. The statistics in Table 1 demonstrate sufficiently that DRC has a good quality crude oil. Additionally, Table 2 further below assists with more evidence and reveals some important crude oils properties or classes according to their origin from the world oil trade. Table 2 indicates the API gravity/sulphur classification from each of type/category of crude oils.

Table 2 illustrates the characteristics of crude oils produced from other world regions, in terms of quality on/or after/between 2008 and 2030. It indicates respectively an average characteristic of crude oil that fall between Light Sweet/Sour and Heavy Sweet/Sour. Therefore, the Medium-Medium Sour appears to be the quality that fall in the intersection between Light crude oil and Heavy crude oil. For example, the Daqing Medium-Medium Sour from China has 33.0 API degrees of gravity and 1.1 Sulphur; and through continual extraction, it could have an average of 32.9 API degrees gravity and 1.3 Sulphur Wt. % in 2030 (ICCT, 2011). Therefore, it is significant to understand that crude oil quality or API gravity can decline and the Sulphur Wt. % can increase through the on-going process of crude oil production on the same field for a long period of time.

This decline of API gravity or increase of Sulphur Wt. % can be justified by two factors, including a slow devaluation of crude oil quality, for example, from Light Sweet to Light Sour due the continual and long-term extraction or production process. In the meantime, Table 3a, b & c makes known the Middle East preferred light crudes API gravity degree by means of countries (Open Oil Report, 2013).

Table 3a
CRUDE OILS CLASSIFICATION IN EGYPT

Country	Type of crude oil	API Gravity	Sulphur	Comment
Egypt	The Suez Blend	33^0	1.4	Egypt's benchmark oil blend sold at a discount to the Brent contract because of its relatively high sulphur content Falling mid-range The heaviest kind of oil in Egypt
	The Belayim Blend	26^0	1.6	
	The Ras Gharib Blend	22^0	1.7	

Table 3b
CRUDE OIL QUALITIES IN IRAN

Product Name	API Gravity	Sulphur content (as % of mass)
Doroud	34°	2.5%
Foroozan Blend	29.7°	2.34%
Iran Heavy	30.2°	1.77%
Iran Light	33.1°	1.50%
Lavan Blend	34.2°	1.93%
Mediterranean Sidi Kerir (Heavy)	30°	-
(Mediterranean Sidi Kerir (Light)	34°	-
Nowruz/Soroush	18-19°	3.4-3.5%
Siri	33.4°	1.81%

Source: Open Oil Report (2013)

Considering Table 4, the following understanding can be specified:

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- The Iran Light crude oil API gravity degree is 33,1 and 1.50% of Sulphur Wt.%, which is less light than the DR Congo's crude oil (33, 70 API degrees gravity and 0.13 of Sulphur Wt.%, higher and better than Iran light crude characteristics).
- The Iraq Light crude oil API degree gravity is 34 and 2.1% Sulphur Wt.%; lighter than the DR Congo's API degree gravity but containing more Sulphur Wt.% than the DR Congo's sulphur Wt.%.
- Egypt Light crude oil API degree gravity is 33 and 1,4% sulphur Wt.%; less light than the DR Congo's crude oil API degree gravity and contain more Sulphur Wt.% than the DR Congo's crude oil (33, 70 API and 0.13 Sulphur).
- Syria Light crude oil API gravity degree is 38 and 0.68 Wt. % of sulphur; lighter than the DR Congo's crude oil, but heavier in terms of sulphur contain.

Table 3c
CRUDE OIL QUALITIES IN IRAQ

Crude oil	API Gravity	Sulphur content
Basra Light	34°	2.10%
Basra Medium	30°	2.60%
Basra Heavy	22-24°	3.40%
Basra Blend*	32°	1.95%
Kirkuk	35.8°	n/a

Source: OpenOil Report (2013)

Once again, considering the Middle East countries' crude oils classification, the API degree gravity and Sulphur Wt. % are illustrating that the DRC's crude oil API degree gravity and Sulphur content can be classified between Light sweet and Light Sour or between Light sour and Medium-Medium Sour. However, as stated earlier, there are more than 150 crude grades, which are treated globally, and many of these are streams blended from two or more fields and that no two crude oils are the same (James, 2007). This implies that the DRC's crude oil has its own chemical characteristics, which may differ from those produced in other world regions. The benchmark of API degree gravity and sulphur content to classify the value of a certain crude oil is universal. The principle to range light or heavy crude oil is internationally agreed at the way it is demonstrated in Table 1, 2 and 3. Based on the universal principle or benchmark, the physical/chemical properties of crude oil produced in the Kongo Central province of the DRC can never be labelled as a heavy crude oil.

Table 4
DATA OF API GRAVITY AND SULPHUR CONTENT IN THE UNIVERSAL CRUDE OIL

Oil field/Country	API°	S %	*CS %	**DF %	Oil field/Country	API°	S %	*CS %	**DF %
Oman oil	32.5	1.14	0.89	0.25	Dukhan/(Qatar)	41.1	1.22	0.41	-0.54
Dubai oil	30.4	2.13	1.03	1.10	Dulang/(Malysia)	37.6	0.05	0.59	-1.61
Print oil	37.5	0.46	0.60	-0.14	Duri/(Indonesia)	20.8	0.2	1.81	-0.65
ESPO oil	34.8	0.62	0.75	-0.13	EA/(Crude)Nigeria	35.1	0.08	0.73	1.10
Abu/Bukhosh/Abu Dhabi	31.6	2	0.95	1.05	East MS Mix/(US)	30.9	2.1	1.00	-0.28
Agbami/Nigeria	47.2	0.044	0.13	-0.08	Ekofisk Blend/(Uk)	37.5	0.32	0.60	-0.24
Aktobe/Khazakhstan	41.6	0.73	0.39	0.34	ElSharal(Libya)	43.1	0.07	0.31	-1.59
Alshahen/Qatar	26.5	2.49	1.31	1.18	Enfield/(Australia)	21.7	0.13	1.72	-1.32
Aljurf/Libya	30	1.9	1.06	0.84	Escalante (Argentina)	24.1	0.19	1.51	-0.13
Alaska/North slope	31.9	0.93	0.93	0.00	Espo-Blend/(Russia)	34.8	0.62	0.75	1.10
Alba/Guinea	53	0.02	-0.11	0.13	Fateh (Dubai)	30.4	2.13	1.03	0.50
Alba/UK	19.4	1.24	1.95	-0.71	Flotta(UK)	35.4	1.22	0.72	1.26
Albian/Heavy/Canada	19.6	2.1	1.93	0.17	Foroozan-Blend (Iran)	29.7	2.34	1.08	0.00
Algerian/Condensate	68.7	0.001	-0.64	0.64	Furrial/(Venezuela)	30	1.06	1.06	-0.74
Amenam-Blend/Nigeria	38.2	0.12	0.56	-0.44	Girassol(Angola)	29.9	0.32	1.06	-1.65
Amenam-Mars/Nigeria	33.5	0.94	0.83	0.11	Grane(Norway)	18.7	0.38	2.03	-0.23
Ameriven-HamacaVenezuela	26	1.55	1.35	0.20	Handil mix/(Indonesia)	43.9	0.05	0.28	-1.23
Amna-Libya	36	0.17	0.68	-0.51	Harding (UK)	20.7	0.59	1.82	-0.91

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Arab extra light/Saudi Arabia	39.4	1.09	0.50	0.59	Hedrun(Norway)	25	0.52	1.43	-0.37
Arab/Heavy/Saudi Arabia	27.7	2.87	1.22	1.65	Hiberina/(Canada)	34.4	0.41	0.78	0.73
Arab Light/Saudi Arabia	32.8	1.97	0.87	1.10	Iran/(Heavy)	30.2	1.77	1.04	-0.54
Arab medieum/Saudi Arabia	30.2	2.59	1.04	1.55	Iran/(Light)	33.1	1.5	0.85	0.65
Arab super light/Saudi Arabia	50.1	0.09	0.00	0.09	Isthmus/(Mexico)	33.4	1.25	0.84	0.41
Asgard-Blend/Norway	50.5	0.07	-0.01	0.08	Kirkuk/(Iraq)	33.9	2.26	0.81	1.45
Azeri BTC/Azerbijan	36.1	0.14	0.68	-0.54	Kitina/(Congo)	36.4	0.11	0.66	-0.55
Azeri light/Azerbijan	34.8	0.15	0.75	-0.60	kole/(Cameron)	32.1	0.33	0.92	-0.59
BCF-17/Venezuela	16.5	2.53	2.28	0.25	Kuwait-Blend (Kuwait)	30.2	2.72	1.04	1.68
Balder/Norway	30.1	0.48	1.05	-0.57	Laguna (Malysia)	10.9	5.4	3.13	2.27
BaoBab/Ivory Coast	23	0.46	1.60	-1.14	Lavan-Blend/(Iran)	34.2	1.93	0.79	1.14
Barrow (Australia)	36.1	0.05	0.68	-0.63	Liverpool Bay/(UK)	45	0.21	0.22	-0.01
Basrah Light/Iraq	30.5	2.9	1.02	1.88	Lower Zakum/(Abu-Dhabi)	39.8	1.02	0.48	0.54
Bayou Chactow(sour)/US	32.2	1.43	0.91	0.52	Loreto/(Pero)	18.1	1.3	2.09	-0.79
Bayou Chactow(sweet)/US	36	0.36	0.68	-0.32	Lufeng/(China)	33.3	0.06	0.84	-0.78
Bayuundan(Australia)	55.9	0.07	-0.22	0.29	Marib light/(Yemen)	48.9	0.07	0.05	0.02
Belanak(Indonesia)	47.8	0.02	0.10	-0.08	Marlim/(Brazil)	19.6	0.67	1.93	-1.26
Belayim Blend (Egypt)	27.5	2.4	1.24	1.16	Maya (Maxico)	21.8	3.33	1.71	1.62
Beryl/UK	37.5	0.42	0.60	-0.18	Mayna/(Peru)	21.5	0.5	1.74	-1.24
Bintulu condensate (Malysia)	69.3	0.03	-0.66	0.69	Medanito/(Argentina)	34.9	0.48	0.75	-0.27
Bonga (Nigeria)	35.5	0.99	0.71	0.28	NFC II /(Qatar)	57.95	0.23	-0.29	0.52
Bonny light/(Nigeria)	33.4	0.16	0.84	-0.68	Napo/(Ecuador)	19	2	1.99	0.01
Boscan/(Venezuela)	10.1	5.7	3.29	2.41	Nome/(Norway)	30.8	0.22	1.00	-0.78
Bouri/(Libya)	26.3	1.91	1.33	0.58	Oman-Blend	34	2	0.80	1.20
Bow river/(canada)	24.7	2.1	1.46	0.64	Oso-Nigeria	45.7	0.06	0.19	-0.13
Brega/(Libya)	39.8	0.2	0.48	-0.28	Pang Lai/(China)	21.8	0.29	1.71	-1.42
Brent Blend/(UK)	38.3	0.37	0.56	-0.19	Plutonio/Angola	32.6	0.39	0.89	-0.50
CPC Blend/(Kazakhstan)	45.3	0.56	0.21	0.35	Port Hudson/(US)	45	0.05	0.22	-0.17
Cabinda/(Angola)	32.4	0.13	0.90	-0.77	Premium-Albian (Canada)	35.5	0.04	0.71	-0.67
Cano Limon/(Colombia)	29.2	0.5	1.11	-0.61	Qatar marine	35.8	1.47	0.69	0.78
Captain (UK)	19.2	0.7	1.97	-1.27	Rabi light/Gabon	37.7	0.15	0.59	-0.44
Cebia(Guinea)	29.9	0.57	1.06	-0.49	Rincon/Argentina	35.8	0.39	0.69	-0.30
Cepu /Indonesia	32	0.15	0.92	-0.77	Sahran blend/Algeria	45	0.09	0.22	-0.13
Cerro Negroo/(Venezuela)	16	3.34	2.35	0.99	Santa/Barbara/Venezuela	39.5	0.49	0.49	0.00
Champion/(Brunei)	28.7	0.13	1.15	-1.02	Senipah/Indonesia	51.9	0.03	-0.07	0.10
Chim Sao/(Vitnam)	40.1	0.03	0.46	-0.43	Siberian light/Russian	35.1	0.57	0.73	-0.16
Chinguetti(Mauritania)	28.3	0.49	1.18	-0.69	Siri/Denmark	38.1	0.22	0.57	-0.35
Cinta(Indonesia)	31.1	0.09	0.98	-0.89	Sirri/Iran	33.4	1.81	0.84	0.97
Clair/(UK)	23.7	0.44	1.54	-1.10	Sleipner/Norway	62	0.02	-0.43	0.45
Cold lake/(Canada)	21.2	3.7	1.77	1.93	Souedieh/Syria	24.1	3.9	1.51	2.39
Cooper/(Ausralia)	45.2	0.03	0.22	-0.19	South arne/Denmark	37.71	0.21	0.59	-0.38
Cossak/(Australia)	47.7	0.05	0.11	-0.06	Tabs blend/Malaysia	50.2	0.03	0.00	0.03
Cusiana/(Colombia)	43.1	0.14	0.31	-0.17	Triton/UK	37.5	0.32	0.60	-0.28
DUC/(Denemark)	33.6	0.26	0.82	-0.56	Upper Zakum/Abu Dhabi	32.9	1.78	0.87	0.91
Dalia/(Angola)	23.6	0.51	1.55	-1.04	Urucu/Brazil	42.1	0.09	0.36	-0.27
Daqing/(China)	32.2	0.11	0.91	-0.80	Varg/Norway	37.9	0.23	0.58	-0.35
Dar-Blend/(Sudan)	36.42	0.12	0.66	-0.54	Vasconia/Colombia	24.5	1.01	1.47	-0.46
Djeno(Congo)	27	0.47	1.27	-0.80	Vityaz/Russia	34.6	0.22	0.76	-0.54
Doba/(Chad)	21.1	0.1	1.78	-1.68	West seno/Indonesia	38	0.12	0.57	-0.45
Doroud/(Iran)	34	2.5	0.80	1.70	White rose/Canada	29.8	0.32	1.07	-0.75
Draugam(Norway)	39.9	0.15	0.47	-0.32	Zarzaitine/Algeria	42.8	0.06	0.33	-0.27

Source: Awadh & Al-Mimar (2015)

Table 4 illustrates Data of API gravity and sulphur content from the universal crude oils, based on oil field per country. Unfortunately, by observing objectively or acutely this Table 4, crude oil produced in the Mibale field of the DRC, discovered in 1973 by Chevron

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(the American multinational Oil and Gas Company) is not included. This could suggest that the statistics or characteristics of crude oil produced in the Congo Central province of the DRC may be unknown or not (internationally) available online. If this may be the case, then it is possible to disclose or affirm that the political influence over the management of the petroleum industry in the DRC is very strong on the fact that important/accurate information related to the produced crude in the country is obstructed or clouded to knowledge of Congolese people, researchers, and other opinions. Therefore, Twendele & Mayimona (2012) stated that the Congolese oil and gas industry is a mystery that keeps its secret well and oil is a well-protected fortress, almost the State secret that nobody knows except those who squat the corridors of power. This implies that all around the DRC's petroleum industry is State top secret, and nothing allows disclosing accurately details of business negotiated between the DRC's State and foreign partners. The lack of information concerning the characteristics of the produced crude oil in the DRC, in Table 4, can be considered or not as a simple omission. In one hand, if it is a simple omission, because not all the oil producing countries member of the Gulf of Guinea including Liberia, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Gabon, Equatorial Guinea, Congo, São Tomé and Príncipe, Congo DRC and Angola including Cabinda (Allen, 2012) are in this Table 4, then this paper brings an additional information aligned to the characteristics of crude oil produced in the DRC, taking into account statistical Data provided further below. In the other hand, if it is deliberately left out, then many questions need to be asked, given that possibly a perpetual weak political (institutional) situation sustained by a group of individuals in connivance with multinational companies may not want accurate information concerning crude oil produced in the DRC to be disclosed due to the political interest involving those who squat the corridors of power and multinational national oil companies implicated. Furthermore, a possible assumption could also be related to the lack promoting the best practice of existing policies, good governance, accountability, and transparency in the management of oil and gas activities in the country. Consequently, corruption could be one of the tools used to not provide accurate information about oil and gas activities in the country.

The Physical/Chemical Properties or Specifications of the DRC's Produced Crude Oil

Discussion related to the physical characteristics of crude oil produced in the Kongo Central province of the DRC was objectively and specifically illustrated in the section above. This section attempts to confirm essentially the accuracy of statistics of the DRC's crude oil characteristics such as revealed by Bafala in 2006, which attested that the DR Congo has a good crude oil quality like that of the Middle East crude oil standard (API degree gravity) and contains less sulphur comparing to other regional or international crude oils. This affirmation is demonstrated in Table 1, 2 and 3. Therefore, according to Bafala (2006), the DRC's crude oil API degree gravity and sulphur content are as follow:

- Density: 33.70 gravity API.
- Density at 15 degree C: 0, 8562.
- Sulphur (% weight): 0.13%.
- Flow point: + 24.
- Crude equivalence of the Middle East: 1,312.
- Debit topping: 1,730.
- M3 /h 82.

Consequently, based on the evidence displayed in this paper, it can be acknowledged that the composition or characteristics of the DRC's crude oil can be ranged between Light

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sweet and light sour. In other words, the DRC's crude oil cannot be classified in the range of Medium sour, heavy sweet or heavy sour crude oils. Boardman energy partners (2015) specified that the international conventional density standard of crude oil is classified following the American Petroleum Institute standard (API gravity), which is demonstrated in this paper. However, the official Report of statistics of the DRC's crude oil from the Department of hydrocarbons (government) is demonstrated in Table 5.

Table 5
SPECIFICATION OF THE DRC'S CRUDES OIL

LOCAL CRUDE OIL SPECIFICATIONS	PHYSICAL CHARACTERISTICS OR APPEARANCE
Specific density at 15oC (60°F)	0.8562
Density API at 15oC (60°F)	31. 2 - 33.70
Total sulphur	0.13% in gr
Total salts (after desalting)	20 to 100 Ib/bbl
Pour Point	21 to 27 °C (70 - 80°F)
Metals Level / V	17/1 ppm
Waxes	19 % in weight
Mercaptans	4 ppm
Free H2S	< 1 ppm
Nitrogen	0.19 % in weight
Viscosity at 104° F	18.5 csts
Viscosity at 122° F	3.88 csts
Acidity	3.16 mgr KOH/gr
Carbon residue	4.1 % in weight
Heptane insoluble	0.02 % in weight

Source: General Secretary of the Ministry of hydrocarbons: Department of exploration, production, and refining (Document handled to the researcher in June 2016 during the interview process).

Table 4 discloses additional information demonstrating the specifications of local produced crude oil, which is like the statistics provided by (Bafala, 2006). Basically, it is important to unveil that there is no confusion or misunderstanding about the density of crude oil produced in the country. Only, it can be observed that there have been wrong opinions, which were politically promoted for political interest. SOCIR, which was supposed to process it locally, has had technological infrastructure challenges, which was inappropriate, inadequate, and outdated to process local produced crude oil and other crude oils from the Middle East region, for which it was established. According to Bafala (2006), SOCIR has had the history of a simple oil refinery industry since it was commissioned in1963 until the breakdown in 1998. Therefore, James (2007) postulated that the simplest refinery like SOCIR has the limited facility or ability to change the configuration of the crude oil input and it has the lowest margin and is often operated by small, niche players. In addition, the technology used by the simple refinery today is the very oldest, which often refers to topping or hydro skimming refinery. Thus, the real problem affecting the petroleum industry in the DRC is not the characteristics or the physical/chemical appearance of crude produced in the Kongo Central province of the DRC, but the real problem is that the country lacks an upgraded processing infrastructure to refine local crude oil. The confusion and misperception about the real density of the produced crude oil in the country is mainly a political secretive matter.

The political Environment Aligned to Crude Oil Production in the DRC

The potential for oil and gas production is huge in the DRC. Oil and gas production can bring enormous wealth to the DRC and its people, not to mention the ability the country's gas reserves could have to produce electricity to power homes and industries. But the major obstacle remains the business environment instabilities and particularly, the poor political

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environment aligned to the management and administration of natural mineral resources, including crude oil production and the entire petroleum industry development in the DRC. The country's oil and gas laws were well developed. Unfortunately, the most important problem remains the political reputation of the country and the lack of best-practice of the country's oil and gas laws. According to Smit (2015), the political environment includes the ruling government, its political institutions or regulation involvement in the business of oil and gas situation. As the primary constituent of the macro-environment, the government influences the oil and gas industry environment as a ruling force that promulgates and enforces laws with measures that are usually politically directed.

The government plays the role of implementing policies which are profitable to communities' socio-economic well-being and which steering or piloting development in the country. According to Shikhar (2010), government regulations include employment law, antitrust law, discrimination law, consumer law, and safety and health law, etc. These factors/laws can have impacts on how the oil industry operates its costs, and the supply and demand for oil products. Bargorett (2014) acknowledged that political factors can affect or promote the oil industry in various ways; through fair decision on transparency about all activities related to oil operations (including exploration, production, transportation, transformation, distribution, commercialisation, marketing, and exportation), prices and oil supply directly, political stability or instability and fiscal policy. As an owner of hydrocarbon resources, the government of DRC also regulate and sell concessions to different local or international companies, and controlling the exclusive rights for exploration, production, and hydrocarbon reserves. Furthermore, government policies govern the energy industry and have the degree of intervention in the economy. In the DRC, all these principles exist, powerful on paper but powerless/useless in practice. The lack of policies best-practice is one of the strong challenges affecting socio-economic activities development in the country. This implies that political decisions have many effects when it comes to oil and gas business activities in the country. They can be profitable or harmful to the country.

These decisions involve aspects like workforce capacity development, quality of oil products and improved infrastructure such as rail, roads, and health of the nation (Shikhar, 2010). However, the political challenges affecting the petroleum industry in the DRC are many. They are similar to those which are still affecting the entire country: the business environment instabilities. Therefore, the political secretive facet of oil activities in the DRC (oil operations/statistics are not accurately revealed), its strong politicisation, contract secrecy and fraud around the oil fields, uncertainty and delays in instituting and implementing laws, programmes, policies or strategic plans have led to a situation where mismanagement (corruption) plays a major role in fuelling confusions, opacities and uncertainties with reference to oil and gas statistics and operations in the Kongo Central province of the DRC (CIA World Factbook, 2015). According to Miles (2012), in the DRC, around 20 companies were involved in the exploration and production of crude oil. Unfortunately, critical concerns were raised about the lack of interest regarding the development of oil and gas processing industry, as well as concerning the opacity of contracts signed between the government of the DRC and certain of these corporates. The specific critical concern included the lack of transparency in the management of natural mineral resources and the total disintegration of the DRC's oil and gas industry in terms of networking/linking the upstream to downstream oil and gas industry, via the midstream sub-sector. Consequently, the lack of transparency (corruption) in the petroleum industry, as well as in different other sector of the economy is challenging the vision for industrial development and socio-economic transformation in the country. This situation will continue to fuel more confusion and cost or limit the country from

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investing or improving the life of many Congolese people. This suggests that whether in the petroleum industry or in other sector of the economy, the poor political environment is socio-economically devastating. According to Pauw (2014), in the DRC, the political factor remains the key factor that negatively affects the business of oil and gas industry.

It is clearly indicated that most Production Sharing Agreement (PSA) or contracts signed for oil exploration and production in the DRC are politically negotiated without any ambition associated with Corporate Social Responsibility (CSR) best-practice or ambition for socio-economic transformation. What create more confusion and suspicion of massive fraud in relation with crude oil produced in the country is that since many decades (from 1973 until today) the capacity of produced crude oil per barrel per day in the Kongo Central province has never changed (25000 barrel/day). Because of massive fraud, corruption and political interferences or secrecy in the petroleum industry, there is way to doubt or ask questions about the accuracy of the official statistics of crude oil production per barrel per day. It seems to be reasonable that Congolese are fuelled with much confusion, doubt and misunderstanding concerning both the statistics of crude oil production per barrel per day, as well as its physical/chemical characteristics (density API or Sulphur Wt.%) in the country. The accurate statistics of oil operations in the DRC are kept top secret and without doubt, even the government of the DRC may not know exactly or may not be in possession of the exactitude of statistics of crude oil production in the Kongo Central province. Any attempt to investigating the accuracy of crude oil statistics by independents or private investigators is like a declaration of war against top Congolese political individuals and multinational companies involved in the business of oil exploitation in the country.

All types of agreements in the petroleum industry are signed in total exclusion of transparency or Congolese community being involved; everything remains to secret; there is no leak of information, and nothing allows disclosing accurately details of business negotiated between the government of the DRC and foreign partners. Furthermore, the lack of best-practice of existing laws, such as enforcing and well-implementing energy policies and regulations remain the major constraints that continue to cloud and affecting the oil industry development in the country. According to Twendele & Mayimona (2012), the Congolese oil and gas industry is a mystery that keeps its secret well and oil is a well-protected fortress, almost the State secret that nobody knows except those who squat the corridors of power. For example, several contracts signed are based on political affiliation or State's political friendship. As an illustration, the South African City Press newspaper revealed that the political environment in the DRC interrupts the oil industry development (Pauw, 2014). This implies that in the DRC, the political factor represents the key sensitive variable that is causing the oil and gas industry to remain disintegrated, underdeveloped, and ineffective in terms of contributing to economic growth and social transformation.

Commonly, it is known that the various socio-economic crises in the country are linked to poor and negative political interferences in the business environment. In addition, the lack of clear mechanism for the delegation of authority is preventing the effective implementation of the government's financial decentralisation policy and various weaknesses undermine the Government's effectiveness and confidence in the institutions. According to the African Development Bank Ranking Report (2013) the DRC's government has respectively ranked in the 5th and 10th percentile of categories control of corruption and accountability. This situation may seem to be the same currently, given that nothing shows change or improvement in all aspects of the business environment. Therefore, efforts to ensure the best-practice of the rule of law (existing programmes, policies, regulations, and strategic plans), could guarantee perspective for change and determination in the process of

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tackling or reducing fraud and corruption in the oil industry. Less political interferences could be the vital key in promoting transparency and the accuracy of crude oil operations (accurate statistics), as well as to ensuring the best management and administration of the petroleum activities in the country. Thus, the government interventions as a regulator force should remain an essential role in imperative to promoting and improving environmental law, trade restriction, tax policy, labour law, tariffs, and political stability strategy to ensure progressive investments in the country.

METHODOLOGY

This study used mixed method design. According to Creswell (2015 & 2018), the mixed approaches follow the general process of research that consists of identifying a problem, determining research questions, collecting data, analysing data, and interpreting results. The converged parallel design framework was used for this study, by purpose of reflecting the process of interaction, priority, timing and mixing data. Quantitative data collection and analysis, and qualitative data collection and analysis were therefore designed following the framework involving descriptions, relationships, comparisons, and as well as predictions (Creswell, 2011). The Likert scale instrument was used to assess how research participants agreed with research question and helped to uncover differences from one respondent to another based on their understanding towards a given statement (Sekaran & Bougie, 2013). Furthermore, Sekaran & Bougie (2010) advocated that a sample size larger than 30 and less than 500 are appropriate for most research. Consequently, a total of 105 respondents from the DRC's petroleum industry participated in this study. Participants from SOCIR (Congolese Company of Oil Refinery's Industry) managerial team; COHYDRO (Congolaise des Hydrocarbures); Ministry of hydrocarbons (DRC); Petroleum and Gas Institute (IPG); public and private professionals' workers in the petroleum industry were involved in this study. These organisations were carefully and objectively chosen or targeted based on the nature of information, for which they were fully cooperative and available to communicate openly with the researcher. Their knowledge and experience in the oil field constituted a significant asset or source of information to the completion of this study.

However, SOCIR management was selected because of the challenges experienced by the oil refinery and in order to get their views or opinions about the role played by SOCIR in the socio-economic environment and perspective for future upgrading and operational project of the oil refinery in the country; COHYDRO stands as the government principal agent, which is leading the global petroleum industry's operations in the DRC and dealing with all hydrocarbon affaires in the country; the Ministry of Hydrocarbons was selected in order to understanding the regulations and legislations that are currently influencing the petroleum industry operations in the country and their perception regarding the oil and gas industry development in the country; the Petroleum and Gas Institute (IPG) is the first training academic institution in the field of oil and gas business in Central Africa, which is now training future leaders who will have to evolve their career in the Congolese oil and gas industry, as well as in other African countries. The students and administrative staff of IPG were selected to acquire academic perspective and criticism in relation with the nature of crude oil produced in the country; and other public and private professional workers within the petroleum industry were targeted for the necessity of acquiring various opinions concerning crude oil properties. In analysing data, this study used the Statistical Package for Social Sciences (SPSS version 24.0) software programme for the quantitative data analysis and NVivo Pro software package version 11 (descriptive and thematic text analysis) for the

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qualitative data analysis. The coding and generation of themes for qualitative data analysis were done using the NVivo software package. Therefore, themes from qualitative data were compared to the main themes related to quantitative results. Interviews involved five of the administrative managers selected form COHYDRO; the Ministry of Hydrocarbons; the Petroleum and Gas Institute; and SOCIR. Through NVivo software package, respondents from these organisations were individually coded using R1 for COHYDRO; R2 and R3 for the Ministry of hydrocarbons; R4 for the Petroleum and Gas Institute; and R5 for SOCIR. Further, qualitative data collected involved the critical perception of experienced respondents in the DR Congo's oil and gas industry. Furthermore, the interview data and the quantitative data collected were analysed by means of using macro-environment variables. These variables included the PESTIE factors (Political, Economic, Social, Technological and Ecological environments). However, a chi-square test was used to signify whether the difference in scoring patterns were significant, the purpose of which is to nullify the hypothesis that suggests the scoring for each statement is the same. The scoring pattern for the statement pointed out significant differences as their p-values were mostly less than the level of significance (0.05). Moreover, another chi-square test was used to determine significant relationships between the variables. A bivariate correlation was performed as well on the ordinal data, where positive values displayed a directly proportional relationship between the variables, and negative values indicated an inverse relationship; significant relationships were indicated by an asterisk.

Findings and Discussions Aligned to the Physical or Chemical Characteristics of Crude Oil Produced in the DRC

The findings and discussions over the physical/chemical properties of crude oil produced in the Kongo Central province of the DRC were presented following descriptive and inferential levels. However, respondents' views/opinions concerning the physical/chemical properties of crude oil produced in the DRC are provided in sections further below. The following abbreviations were applicable:

API: American Petroleum Institute
COHYDRO: Congolaise des hydrocarbures (French), Congolese of hydrocarbons (English): State Agency
DRC: Democratic Republic of Congo
IPG: Petroleum and Gas Institute (DRC)
PESTIE: P= Political; E= Economic; S= Social; T= Technological; I= International; E= Ecological
SOCIR: (French: Société Congolaise des Industries de Raffinage), (English: Congolese Company of Oil Refining Industries)

The Physical or Chemical Properties of Crude Oil Produced in the Kongo Central Province of the DRC

Smit (2015) stated that the ecological environment comprises natural resources such as flora and fauna, natural mineral resources, access to water, quality of air, and climate evolution. This study focussed on examining the characteristics of crude oil produced in the DRC. The API gravity was designed to measure a wide range of crude oil specifications, from 10 degrees API to 70 degrees API in order to specify state or identify the specific range of crude oil from different fields. A study on statistical analysis of the relations between API, specific gravity and sulphur content in the universal crude oil (Awadh & Al-Mimar, 2015) revealed that the cumulative frequency analysis shows that nearly70% of the API° values are

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located within the interval 30 to 70 indicating light oil, and the remnant API (30%) is heterogeneously distributed within the interval varies from 10 to 30 indicating medium to heavy oil. Furthermore, about 57% of crude oil samples contained S% less than 0.5 defining sweet oils, while the other samples (43%) represent sour oil. In addition, Awadh & Al-Mimar (2015) emphasised that the API° is inversely affected by S%. Consequently, the study conducted by Awadh & Al-Mimar (2015) confirmed that the sulphides are evenly distributed over medium and heavy factions of crude oils. Considering the above findings, in this study, respondents were required to indicate their opinions or perceptions concerning the physical/chemical density of crude oil produced in the Kongo Central province of the DRC, as well as the challenges experienced by SOCIR in relation with the characteristics of local produced crude oil. In addition, respondents were also required to point out the degree of their perception concerning the effects that SOCIR upgraded could have on the ecological environment regarding the processing of local produced crude oil. Their opinions and verdicts are presented in Figure 1.

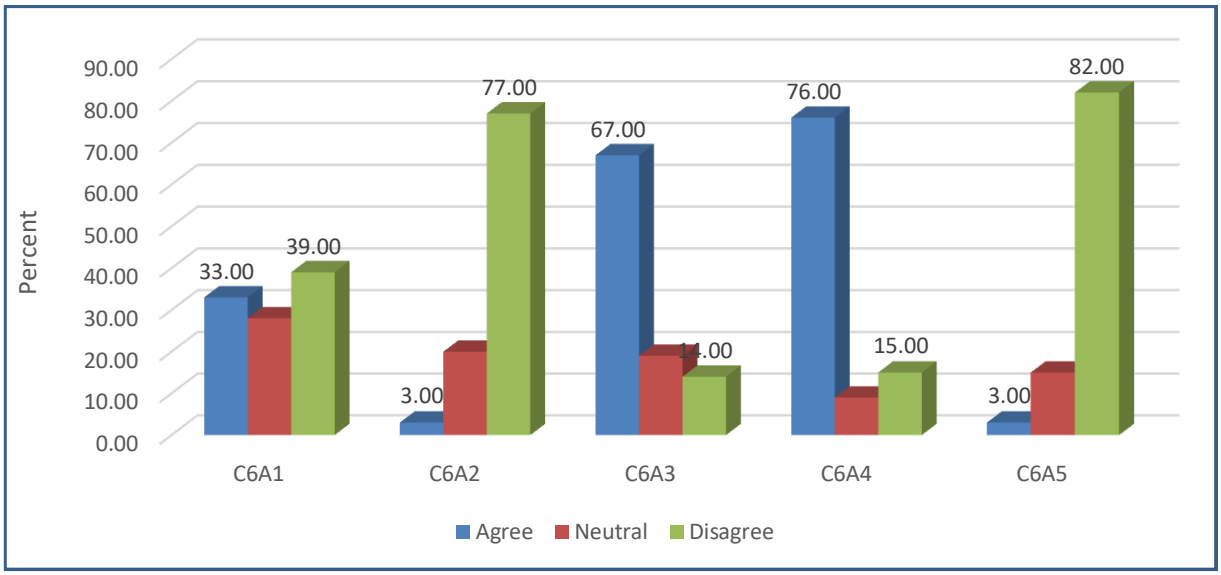

FIGURE 1
THE PHYSICAL PROPERTIES AND CHALLENGES EXPERIENCED BY SOCIR IN RELATION WITH CRUDE OIL PRODUCED IN THE KONGO CENTRAL PROVINCE OF DRC

Figure 1 illustrates the opinions of respondents aligned with the physical properties and challenges experienced by SOCIR in relation with crude oil produced in the Kongo Central province of DRC. It displays the statistics, which attest that there are significant misperceptions and confusions that are overshadowing the real density or properties of the DRC's produced crude oil. Many Congolese, even high qualified respondents who participated in this study have shown a certain degree of misunderstanding/confusion concerning the physical or chemical properties of crude oil produced in the Kongo Central province of the DRC. However, a close view from Figure 1 indicates that the higher portion of respondents (C6A5: 82%) showed self-assurance in the fact that the DRC's produced crude oil density is not light at all and that 76% (C6A4) of respondents' have agreed as true that the DRC's produced crude oil density is certainly heavy. Furthermore, 77% (C6A2) of respondents' opinions acknowledged that SOCIR technological infrastructure is unable or

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inappropriate to process local produced crude oil due its unsuited density. Moreover, the findings displayed that 67% (C6A3) of respondents have agreed on the fact that the DRC's crude oil is totally exported because it is heavy and not appropriate to be refined locally by SOCIR.

Additionally, respondents have shown a high degree of confusion and misunderstanding about the real quality or density of the DRC's produced crude oil by the fact that only 15% (C6A4) of respondents have shown self-confidence in that the DRC's crude oil is not heavy, but specifically, they were not sure about its real density; and 15% (C6A5) of respondents were neutral, without indicating any opinion concerning the real quality or characteristics of crude oil produced in the Kongo Central province. Accordingly, a very small number of respondents, 3% (C6A5) have indicated their self-confidence in that the DRC's produced crude oil could have a good quality, ranging between Light Sweet, Light Sour or Medium Medium Sour crude oil classes. But they were uncertain to confirm confidently the relative physical characteristics of local produced crude oil. The lack of displaying accurate information to the public regarding oil and gas activities in the country (by the government or private organisations), is the root cause fuelling this misunderstanding, misperception, and confusion. Thus, the uncertainties about the real physical/chemical statistics of crude oil produced in the Kongo Central province of the DRC remain a topic of further research or investigation, given that confusion and misunderstanding concerning the DRC's produced crude is deeply engrained in the opinion of many Congolese.

Discussions Aligned to Respondents' Perceptions or Point of View about the Characteristics or Density Crude Oil Produced in the DRC

Confusing opinions from respondents about the real characteristics of crude oil produced in the DRC can be justifiable. It was stated earlier that the business environment instabilities, fraud, corruption and political interferences and secrecy are the major factors, which are fuelling confusion and all types of crises affecting the socio-economic environment in general, and particularly, the petroleum industry development in the DRC. In addition, the lack of policies best-practice and specifically, the poor political environment in the DRC have created a situation through which, many Congolese, including educated people continue to be unsure about the real characteristics of local produced crude oil. Many believe that local produced crude oil is heavy and therefore unsuitable to SOCIR refining process. Concerning SOCIR technological infrastructure inability to process local produced crude oil, respondents' opinions may be justifiable, given that the reason through which crude oil produced in the DRC is totally exported to other countries is because SOCIR has had very simple and ageing technological equipment, unable to process it locally. SOCIR was unable to process not only the local crude oil, but even crude oils from the Middle East for which it was commissioned. However, the observation of statistics presented in Table 1, 2, 3 and 4 indicates the imperative to bring more clarity today about the causes of confusion and misperception regarding the physical/chemical characteristics of crude oil produced in the country. Therefore, the political opinions, as well as the opinion presented by multinational oil companies operating in the exploration and production of crude oil in the Kongo Central province of the DRC have dictated and fuelled the opinion of many Congolese, allowing the belief that the DRC's produced crude oil is heavy, so to keep Congolese people ignorant about the real physical properties of the national produced crude oil. Until today, only very little literature acknowledged that the DRC's produced crude oil has a good quality, based on

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the international standard API gravity comparison and which contain low sulphur WT% (Bafala, 2006).

Consequently, the observation of statistics of the DRC's produced crude oil provided by Bafala in 2006 compared to the statistics displayed in Table 4, from the DRC's Department of hydrocarbon in 2016, describe and confirm that crude oil produced in the Kongo Central province (33.70 gravity API and 0.13% sulphur) is not heavy, it is a good quality crude oil that is similar to light sweet, light sour or Medium-Medium Sour produced in other world regions, such as crude oil produced in China, which displays 33.0 gravity API and 0.1% Sulphur; to Iran light crude oil (API gravity 33,1 and 1.50% sulphur, less than the DR Congo's crude oil 33, 70 API and 0.13% of sulphur, or better than Iran light crude oil API gravity); to Egypt light crude oil (API gravity degree 33 and 1,4% sulphur; less lighter than the DR Congo's crude oil API gravity and contain more sulphur than the DR Congo's density (33, 70 API and 0.13% sulphur); and to Libya light crude oil API gravity degree, which is ranging between 32 and 44 API; more lighter, but comparable to the DR Congo's API gravity, such as it ranging between 32 API to 44 API gravity degree (Bafala, 2006; Open Oil, 2013; and ICCT, 2011). Even if there are existing statements that allow the understanding that no two crude oils are homogenous or similar due to their different regions of composition underground (crude oil is not a homogenous raw material, each crude oil produced in the world has unique chemical composition, which varies according to the manner of its formation), but it is globally agreed that the international standard of crude oil varies in terms of classifications based on the API gravity degree and sulphur content, which are provided in Table 1 (the Canadian Fuels Association Report, 2013, the ICCT, 2011 and Jams, 2007).

However, by considering the API gravity and sulphur content of the DRC's crude oil such as discussed further above, it is critically imperative to affirm that the DRC's produced crude oil can be classify in the range of good physical/chemical characteristics of crude oils. Therefore, advanced, and critical research focussing essentially on the physical/chemical properties of the DRC's produced crude oil could bring more light in order to dissipate the existing confusion and misunderstanding clouding the opinion of many intellectual Congolese. Consequently, if nothing is done to advance research in this sector of the economy, poor political interventions (policies, laws, and regulations lack of best-practice) will keep displaying the mystery of black hole, where corruption, fraud and poor political environment will continue to dictate confusion and prevent many poor Congolese from the wealth that petroleum industry can generate. If democracy is still a luxury for the DRC, the best-practice of the rule of law is a sine qua non condition in imperative to monitor accurately socio-economic activities in all sectors of the national economy.

Recommendations

Considering the problematic/challenges affecting the DRC's petroleum industry, it can be recommended that:

The government of the DRC, the current ruling government, and its institutions, as a regulating force, are required to play a significant role that can influence or promote the oil and gas industry development, by promulgating and enforcing laws, regulations, programmes, policies, and strategic plans that can guarantee monitoring and transparency of oil and gas activities in the country. Change in the DRC's petroleum industry could be possible through exercising or ensuring the best-practice of existing policies; as well as promoting civil rights and socio-economic rights, which are human rights in the workplace.

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Policies or programmes for the development of any sector of the economy should not remain powerful black in white letters/scriptures written in the Books, but it should be forcefully and truthfully implemented for common interest. This implies that the best-practice of the principle*: "doing well by doing good"* should powerfully dictate the opinion of policymakers and decision-makers whether in the leadership of the DRC's petroleum industry or in other sector of the national economy.

The government of the DRC must ensure that oil and gas exploration, site development, crude oil and gas extraction or production are meeting the requirements stated in the existing hydrocarbon laws and regulations; and that government interventions in the petroleum industry should guarantee transparency (total control) and accuracy of statistics of oil and gas operations and production in the country.

The rule of law should prevail over all kind of socio-economic activities, in imperative to prevent fraud and corruption fuelled by mismanagement and mal administration of oil and gas activities in the petroleum industry, as well as in imperative to ensuring that Congolese people are highly equipped and trained to participate in all levels of socio-economic activities in the petroleum industry. The government should also ensure that multinational organisations operating in all sectors of the national economy, particularly in the petroleum industry, should strictly comply with the stated laws and regulations that dictate their behaviour in terms of Corporate Social Responsibility best-practice, while they are signing exploration and production contracts or production sharing agreements.

The government should take advantage of the newly discovered up to 20 billion proven barrels reserves of oil in the Eastern region of the country, which align the country second behind Nigeria, which has an estimated 37 billion barrels proven reserves and remote above Angola, which has around 9 billion proven barrels reserves (Titeca & Edmond, 2019), to start planning about the development of a new petroleum processing industry, particularly and that of the entire oil and gas industry development in general. In addition, based on the innovative perspective of the petroleum industry development in the country, the government should also design the integration of the economic activities, in imperative to link the primary sector to the tertiary sector via the processing industry development or the industrialisation of the economy. For example, the project for restructuring and upgrading SOCIR should be amongst government priorities agenda and strategies to reduce the excessive cost of import of petroleum products and prevent the cheapest export of local produced crude oil labelled as heavy in imperative to satisfying the egocentrism of minority people that are maintaining the life of many Congolese in total poverty. Acting in that way could generate socio-economic activities diversification, and consequently reduce or demystify frauds and corruptions. Confusion and misperception of the national produced crude oil could be eradicated through the best-practice of the rule of law and through the best-practice programmes, policies and strategic plans that promote transparency and the development of positive human capital capacity in all socio-economic sectors.

The government of the DRC should promote and support the development of a dynamic research institution in the petroleum industry with mission of identifying challenges affecting the development of the national petroleum industry, as well as indicating the way forward to integrate and develop the entire petroleum industry. Most importantly, the research institution should assist the government in terms of developing capacity development programmes with objectives of empowering the development of positive human capital capacity by conferring the ability or capacity to work productively towards contributing to socio-economic transformation in the country.

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Efforts to developing dimensions of positive human capital capacity that include moral capital (administrative integrity and morale ethics), aesthetic capital, human capital, human abilities, human potentials, and spiritual capital could be a fundamental factor in rebuilding the country's socio-economic activities and development.

It is also firmly recommended that the project to developing a new oil refinery industry in the country or upgrading SOCIR should take into consideration the reality of crude oil characteristics produced or crude oil newly discovered in the Central Basin, the Albertine Graben, and the Tanganyika Graben (IPAD DRC: Infrastructure Partnerships for African Development: Oil and Gas Forum linked to the Democratic Republic of Congo, 2014). Furthermore, innovative processing industry of crude oil in the country should take account of modern technology such as residual fluid catalytic cracking unit, naphtha processing units and the LPG storage unit. For example, the project of improving existing facilities of SOCIR should focus on increasing its capacity of crude oil processing from a fixed volume to an improved complex oil products quality production and adapting SOCIR to meet other regional or international specifications of crude oils. The necessity or objective of developing a new oil refinery in the country or restructuring and upgrading SOCIR could be significant for the following reasons:

- Facilitate the integration and diversification of the economy.
- Facilitate the promotion and development of industrialising industries in the country.
- The oil refinery's modernisation with new or innovative equipment/technology could optimise various units' processes and support the production of environmentally clean fuels both for the local and export markets, as well as prevent or reduce total external dependence on oil and gas products.
- Facilitate the increase of crude oil processing capacity, efficiency, and effectiveness in imperative to produce gasoline at specifications similar to those used throughout international market.
- Provide high levels of accuracy and reliability in demanding refinery applications; and
- Contributing to socio-economic transformation of the DRC, with potential creation of opportunities for new employment development for future generations etc.

Furthermore, through forecasting the development of the national petroleum industry, the government of DRC will have to invest much consideration for oil and gas field services industry development, which is essential for the country to provide support services on oil and gas fields operations (sites development, maintenance, and training services for human capital development) on a contract basis to companies involved in oil and gas activities. The oil and gas field services industry development could promote the establishment and development of companies that provide the infrastructure, equipment, intellectual property, and services needed by the national oil and gas industry to explore, extract, and transport crude oil and natural gas from the earth to the refinery, and eventually to the consumer. The PESTIE factors, which constitute a strong barrier to socio-economic transformation today (challenges) could become the gateway or generator new opportunities, which is expected to create real and tangible change and support a coherent public-private partnership, economic development, and social transformation. It is therefore hopeful and optimistic that the oil and gas industry integration and development in the DRC could cause progressive change and improvement in the business environment.

Continual public and private engagement, based on Win-Win partnership model, is specifically required to accelerate the development of the processing industry in the country, and ensure that oil and gas industry development and integration are socio-economically profitable to the majority of employed Congolese. The government of DRC should engage and make interactions, develop partnership and cooperation with various stakeholders to promote synergy and the achievement of good policies during which gaps are identified early

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and interventions to resolve them are accurately implemented. The government should continually monitor and evaluate the best mechanism of putting into practice policies, programmes and strategic plans that promote and support it obligations and the obligations companies to ensure the best-practice of Corporate Social Responsibility in all sectors of the economy. Accordingly, transparency in the management and administration of natural mineral resources exploration and production remain one of the sines qua non conditions for socio-economic transformation process in the country.

CONCLUSION

This paper examined the misperception or confusion over the specifications of crude oil produced in the Kongo Central province of the DRC based on the international Data of API gravity and sulphur content from the universal crude oil.Therefore, based on different evidence displayed in this paper, it can be observed and agreed that crude oil produced in the Kongo Central province of the DRC has a good and greater value API degree gravity (33.70 and low sulphur appreciated at 0.13%), which is fitting the range of API gravity degree that dictate the standard classifications of light crude oils produced and supplied in the international market. It was indicated that the API degree gravity and Sulphur content standard of good or light crude oil must vary/fall between 26 and 35 API gravity degrees and the property range of Sulphur Wt. % must vary/fall between 0% and 1.1%. This classification represents respectively an average characteristic of crude oil that fall between Light Sweet/Sour and Heavy Sweet/Sour. Therefore, the Medium-Medium Sour appears to be the quality that fall between Light sweet/sour crude oil and Heavy sweet/sour crude oil. For example, the Daqing Medium-Medium Sour from China has 33.0 API degrees gravity and 1.1% Sulphur. The ICCT (2011) emphasised that through continual extraction and production, the Daqing Medium-Medium Sour could have a decreasing average of 32.9 API degrees gravity and 1.3 Sulphur Wt. % in 2030. However, taking into consideration this understanding, the DRC's produced crude oil (33.70 API degrees gravity and 0.13% sulphur) on or before 2008 and 2030 can still fit the criteria of being a good quality crude oil. Until today the statistics of crude oil produced in the Kongo Central province of the DRC indicate no contradiction or change in terms of its characteristics/density such as demonstrated in this paper. In addition, there has been no contraction in terms of the quantity of crude oil production per barrel per day (25000 barrels per day), although this statistic of crude oil production per barrel per day appear to be inaccurately publicised. Moreover, there seem to be lack of literature that have explored and discussed about the accuracy of statistics of crude oil produced in the Congo Central province of the DRC, as well as its chemical or physical density. Thus, it is clear and comprehensible that the DRC's produced crude oil never been heavy such as it has been labelled by local or international opinions. Bafala in 2006 certified that crude oil produced in the DRC is good. The statistical evidence explored in this paper demonstrates and confirm sufficiently that the DRC has crude oil that fit the criteria of being a good quality crude oil. However, it is also acknowledgeable that no two crude oils are the same, crude oil is not a homogeneous raw material and each crude oil produced in the world has unique chemical composition, which varies according to the manner of its formation (James, 2007). Therefore, the DRC's crude oil could differ to other crude oils from its unique chemical composition, which fortunately is not heavy. This study demonstrated and highlighted that it is a politically managed situation that fuelled the degree of confusion and misunderstanding concerning the characteristics or density of the DRC's crude oil to be labelled such as a heavy crude oil. It is simply a popularised opinion, which cannot be

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scientifically or statistically demonstrated. In addition, findings indicated that the DRC's produced crude oil is totally exported not because it is simply labelled as a heavy crude oil, but mostly because of the lack of a suitable upgraded oil and gas refinery in the country to process it locally, given that SOCIR technological infrastructure was commissioned and adapted to process specifically a certain defined crude oil from the Middle East region, not to refine local produced crude oil. Also, SOCIR has had a very simple and old technological infrastructure unable to process variety or range of crude oils.

Thus, confusion concerning the density of produced crude in the DRC is the orchestration or machinery of strong political secrecy to export it cheaply under the label of heavy crude oil, so that Congolese people should not pay attention to which extent this black gold can contribute to the national economy and generate massive employment in the country. Again, respondents have acknowledged that the real problem is not the quality of crude oil: heavy or light that the country may have, but lack of developed operational oil refinery in the country is the real problem. Therefore, the necessity to establish a modern oil and gas refining industry is the way forward or the approach to stop or unpolluted any wrong opinion concerning crude oil produced in the Kongo Central province of the DRC. The DRC indeed will have to develop a new oil refinery industry and/or restructuring and upgrading SOCIR in imperative to increase its processing capacity. The benefit of having a developed oil refinery industry in the country is that it can be able to process all types of crude oils (heavy or light crude oils with low or higher gravity, sulphur and TAN), which could give the country a competitive advantage in terms of minimising the cost of import of oil refined products from other countries, which cost a lot of money to the country; as well as minimising the excessive cost of export of produced crude oil from the country, which is exported at low price and generate low income to the country.

In addition, refining it locally can generate sustainable socio-economic impacts, given that the high-tech processes produce lighter petroleum products, although it is expensive to procure. Yet, the DRC's oil and gas reserves are estimated to be around 20 billion barrels in the country's basins, both onshore and offshore. That is a tremendous amount of oil, which place the DRC as the second biggest petroleum holder in Sub-Saharan Africa, behind only Nigeria, and far outdoing Angola's reserves of 9 billion barrels of oil. Oil and gas processing industry development in the country could facilitate the development of related industries and link the upstream to downstream subsectors. Thus, one would expect that the country's leaders would strongly push for the country's petroleum industry development to produce wealth and provide better living conditions for its citizens. If the country is wealthier, it will become capable of improving the lives of those that live in it, the more stable it will be and the more capable it will become of sustaining and giving continuity to that development. Socio-economic stability of a country like the DRC depends on factors that include business environment factors improvement, investment, cooperation, and development. To attract more investments, conditions need to be created for the business environment to be enabling for industry development. Win-Win contracts could help achieve that. Local communities must not be excluding but participating fully in the process of producing wealth.

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