

Identification and ranking of the most suitable virtual currencies for selling crude oil under sanctions

Sina Sarvi^{a*}

^a M.A. Student, Faculty of Management, Imam Sadegh University, Tehran, Iran, Email: s.sarvi1881@gmail.com

ARTICLE INFO

Keywords:

Virtual currency
Sanction
Crude oil
Petroleum transaction
TOPSIS

Received: 6 December 2018

Revised: 21 January 2019

Accepted: 30 January 2019

ABSTRACT

By intensifying sanctions against Islamic Republic of Iran, identification and development of mechanisms to sell crude oil has gained attention among most experts and oil industry activists. Limitations for financial transactions and settlements are one of the fundamental challenges in international oil transactions; thus, various solutions are proposed to solve the limitation. Using capability of virtual currencies is one of the proposed suggestions for petroleum transaction under sanctions but there is a research gap in finding whether and which one of these currencies are able to be used in petroleum transactions in present condition. In this study, performed by analysis and quantitative approach, indices are introduced for choosing a valid currency for international transactions, and subsequently are confirmed by experts. The indices are ranked by the experts through TOPSIS method and are studied on the most suitable virtual currencies to find the best suit for petroleum transactions. The results reveal that Bitcoin, Ethereum and Tether are respectively the best, second and third choice for this end. It is noteworthy that some experts might believe the virtual currency market size may not meet the high volume of crude oil transactions, making it unsuitable. Although current study has shown that there would be no problem in covering the whole petroleum market for Iran's crude oil by virtual currencies platform, if the concerns remain, virtual currency platform could be used for selling Iran's crude oil temporarily and partially through various channels.

facilitate the process of trade among countries is of importance.

1. Introduction

One of the main challenges of oil-based economies is their dependency on oil revenues and this provides vulnerability background for these economies. Unfortunately, despite acknowledge of some policy makers and experts about Iran's economy dependency on oil revenues, the weakness is still present in the economy of the country and is getting noticeable in sanctions. One of the most important problems in oil transactions is about financial settlement in sanctions. In other words, even if crude oil is delivered to purchaser, current mechanisms perturb the necessary capacities to receive money from the client. Therefore, finding ways to

One may observe the emergence of new technologies, especially cryptography and network computing as a possible solution for this matter. The virtual currency is a private system to facilitate transactions among individuals, without any requirement to central and intermediate entity (Nouri & Navvabpour, 2018). As ECB provides, a virtual currency is defined as a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community (Europe Central Bank, 2012). Virtual currency is conceptually different from digital currency

* Corresponding author

and cryptocurrencies. Cryptocurrencies such as Bitcoin are form of virtual currencies, albeit all virtual currencies are not cryptocurrency (Rajabi, 2019). Virtual currencies and related technologies (Blockchain system) are now rapidly expanding.

One of the important factors for a virtual currency to get viral is its computing power. Designers of virtual currencies develop a mechanism that different beneficiaries join and participate to their virtual currency network based on their computing power. When a person satisfies determined condition of a virtual currency, part of that virtual currency is paid to the individual as form of a new unit or wage; this is called mining (Rajabi, 2019). This mechanism would accelerate the computation process as well as reducing the computing time of the virtual currency, hence, improving its utility for the users.

Classification of the available virtual currencies, especially when there are more than 5000 of them, could be a real challenge. However, it can be a bit easier understanding these currencies when they were separated into different types. Most virtual currencies fall under one of the following categories according to (Bitdegree, 2020): Payment Currencies, Blockchain Economies, Privacy Coins, Utility Tokens, and Stablecoins. For a better illumination, the benefits and representative virtual currency of each category have been presented in Table 1. Each and every one of these representatives has its pros and cons which highly affect its presence and usability in transactions. Thus, the best choice for each of them would be strongly influenced by the nature of those transactions.

Table 1. Different categories for virtual currencies and the representative currency based on the ranking of (CoinMarketCap, 2020).

Category	Main application	Representative virtual currency	Ranking of virtual currency (out of 5075)
Payment Currencies	Payments	Bitcoin (BTC)	1
Blockchain Economies	create unique platforms with its assets, applications, and more	Ethereum (ETH)	2
Privacy Coins	private transactions (only the sender and receiver know the number of coins transacted)	Monero (XMR)	13
Utility Tokens	digital tokens that are used for a blockchain-based product or service	Basic Attention Token (BAT)	31
Stablecoins	Fixed price	Tether (US)	6

Though, for the best implication of them, a good knowledge of both crude oil market and the relevant contracts seems crucial. Up to 1970, crude oil market had mostly been governed by a few giant firms, leading to fixed term contracts. The stability in crude oil prices was helpful for this model, though upcoming fluctuations in the market, made it inefficient. Due to the high volume of crude oil transactions, any instability (either rise or fall) would result in drastic change in the final price, hence, bringing on a high risk to the whole system. In order to manage such a problem, various models have been suggested in two main frameworks of physical and derivative markets that the derivative markets consist of forward and future market. Since real or physical

markets are the major objective in the present research, paper markets or derivative markets are ignored to discuss. Activists of real markets of crude oil are mainly producers, refiners, end consumers, some oil companies and so on. It worth noting that transactions in physical markets are only limited to part of crude oil transactions.

One of the important issues in crude oil transactions is the contracts. Although the experts of the field acknowledge the contracts as a substrate which could reveal various capabilities according to different attributes of every region, all of them suffer mostly similar set of misfunctions. Crude oil contracts typically classify in two different categories: Concessionary

systems and Contractual systems. In the former (the earliest one), the concession has been granted to a foreign company by the government, so that the company would invest in exploration, development, operation and marketing of oil and gas processes, while paying a property interest as well as a part of its net income in the form of tax to the government. The latter one has different types including sharing and service contracts. While none of them could be known as the best or the worst, they provide a mean for forming an agreement between the two parties. Therefore, each one of them would be beneficial in a different condition (Mazeel, 2010). Contractual condition in real markets is different in various contracts, but contraction period, consignment, type and place of sample delivery, destination, price and pricing period, payment,

inspection sample, measurement of crude oil, transfer of ownership and risk and things like this are determined during negotiation (Kameli, 2009). These criteria could be troubling in many cases, making it too much time consuming while the shipment would be delayed until the results to be announced. The cargoes are typically loaded a month or more after the date of the deal because of the time it takes to book space on pipelines, secure a vessel and sail it to the port for its cargo. Because of the complicated logistics, cargoes for immediate delivery are rare (Schaik, 2012). A simple depiction of the process for selling crude oil is presented in **Error! Reference source not found.** Aside from the problem of money transactions, it would cost a lot of paperwork, complicate the process, and reduce efficiency.

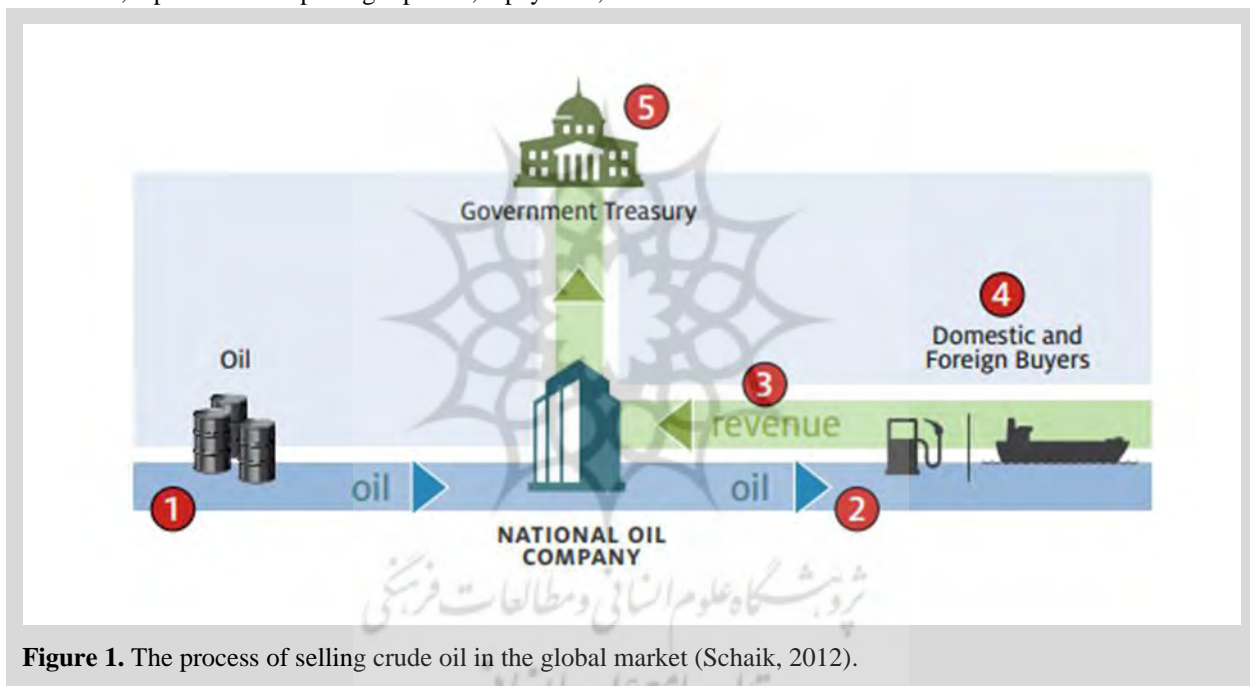


Figure 1. The process of selling crude oil in the global market (Schaik, 2012).

Another influential factor on the crude oil price, the term of the contract, its security, and transparency of the transactions, is the mechanism for selling gas and oil products (Narula, 2018). According to the National Iranian Oil Company (NIOC) (NIOC International Affairs, 2020), the main mechanism for these transactions in Iran is as stated below:

1. Iranian crude oil will be sold only to end users including refiners or oil companies who are in possess a valid and unconditional processing and/or sale agreement with one of the bonafide and active oil refiners.

2. The applicant must be a reputable oil company having appropriate business and financial performance during last three years.

Notes:

- I. Oil Company is a company which is well known for its activities in oil upstream, downstream and / or physical oil transaction.
- II. Appropriate business performance is defined as fulfilling the contractual obligations against parties concerned and having good reputation in execution of its sale / purchase contracts.
- III. The appropriate financial performance is defined as fulfilling the financial obligations under the terms and conditions of oil contracts

on time, without any failure or delay in payments for the concluded transactions.

3. Financial and credit status of applicants must be approved by three prime banks acceptable to NIOC.
4. The applicant should be able to open the required letter of credit for payment of crude oil purchased.
5. Sale of crude oil to the occupied regime of Palestine (so called Israel) is prohibited. Applicant undertakes not to sell and / or process the purchased crude oil to / in the said occupied regime.

A good understanding of the abovementioned lines could help in choosing the best solution for Iran oil and gas transactions through virtual currencies. Yet, gas and oil pricing, similar to any other commodity market, is strongly affected by market's supply and demand. In the long term, this would define the crude oil price, while in the short term, many other factors are in play. Among these factors are oil reservoirs, non-OPEC petroleum supply, and OPEC petroleum supply (Zamani, 1385). However, this procedure could not be successfully implemented due to the oil embargoes. An oil embargo is an economic situation wherein entities engage in an embargo to limit the transport of petroleum to or from an area, in order to exact some desired outcome. One commentator state, "[a]n oil embargo is not a common commercial practice; it is a tool of political blackmail, meant to force those at whom it is aimed, into some action they would otherwise not be willing to take" (Balas, 2012).

Oil embargoes have mostly been implemented by the United States rather than any other countries. Sanctions on Japan before WWII, Former Soviet Union in 1960s, South Africa, Myanmar, Serbia, Haiti, Libya, Iraq, Iran and Sudan in recent decades are some of the examples of those (Abdi, 1385). For decades, oil and gas sector has counted among the major sources of income for Iranian government (Mahdavy & Cook, 1970). Hence, mainly the sanctions were directed at this sector so as to deprive the country from one of its main revenues. Intercepting with the buyers and forcing them towards any other seller than Iran, the oil embargoes have been applied through two prime means: Direct (sanctions on the crude oil

buyers) and non-Direct (ban on insurance of tankers carrying Iranian oil or financial sanctions) (Marvi & Shayesteh, 1394). While almost 89 percent of Iranian foreign trade had been done through SWIFT system, in March 2012 SWIFT announced the termination of any cooperation with Iranian banks and parties, making legal financial transactions almost impossible. Proceeding to the ban, Iran has decided to advantage from barter transactions (Hache & Massol, 2016), exchanging crude oil for gold ("Iran to accept payment in gold for oil," 2012), any commodity from the buyer's country, or any currency rather than dollar. Iranian oil export has decreased to less than 2 million barrels in March 2012 due to these sanctions (Verdier, 2020). Moreover, the refrainment of oil companies from investing on petroleum projects in Iran, old oil wells and depreciation of petroleum extraction equipment, lead to a reduction in Iranian oil production (Azadi et al., 2016). To overcome such a problem, as previously stated, virtual currencies could be considered as a solution. Yet, it is necessary to give a definition for them, so as to have a better perception for the present study.

In the past four years, blockchain technology has begun to emerge in the oil and gas industry. Many energy giants have begun to invest in the development of this technology. At the end of 2017, Sinochem Group successfully completed China's first blockchain crude oil import trading pilot project from the Middle East to China (Milano, 2018). There are two major applications in the project - digital bill of lading and smart contracts, which can significantly improve the efficiency for any Fatwa to be given on any matter, scholars spend so many years researching and studying, thus, as new as the virtual currencies, there still needs a couple of years for them to come out on the conclusion. Efficiency of crude oil trading execution and optimize the transaction financing cost by 20% to 30%. Europe has the largest number of projects, and Asia and Europe have the fastest development in the application of blockchain in the oil and gas industry (Lu et al., 2019). However, out of more than 10 operating and commissioning projects in the field (c.f. Figure 2), none of them have used virtual currencies as the main currency for money transactions.

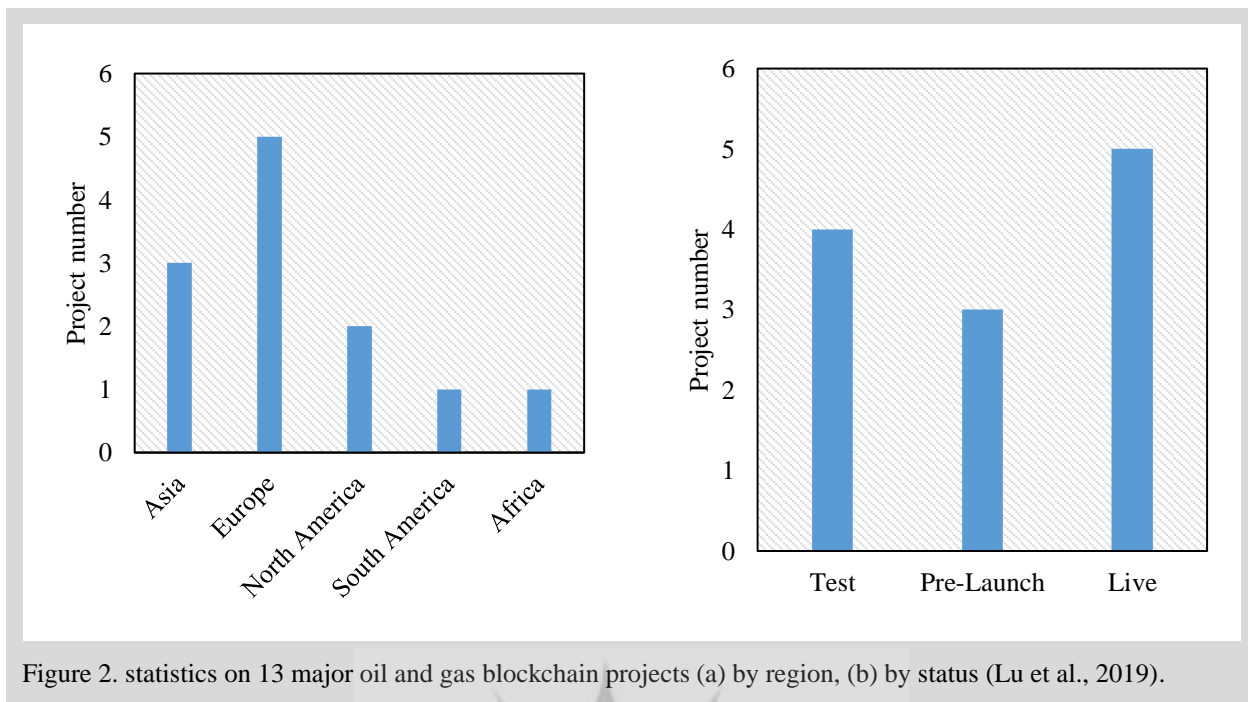


Figure 2. statistics on 13 major oil and gas blockchain projects (a) by region, (b) by status (Lu et al., 2019).

As aforementioned, the problem of sanctions on Iran's economy has posed so many problems, especially for oil and gas industries. Among the potential buyers of Iran's crude oil, herein we focus on those who have been pulling out due to the money transaction difficulties. On the one hand, the impossibility of performing financial transactions in crude oil market is among the biggest problems. On the other hand, virtual currencies have the potential for solving this problem. Though, no study has yet considered this solution. Therefore, in this study, the possibility of using virtual currencies for crude oil transactions has been explored while the applicability of different virtual currencies discussed. The novelties of the present study could be summarized as:

- Exploring the applicability of virtual currencies for petroleum transactions for the first time
- Introducing the most important indices for developing a platform of virtual currencies in Petroleum market for the first time
- Ranking available virtual currencies based on their suitability for petroleum transactions for the first time
- Introducing the most suitable virtual currency for the petroleum transactions for the first time
- Providing a perspective on jurisprudential aspects of virtual currencies due to the Islamic laws in Iran for financial matters

Such a study has never been performed to the best knowledge of authors; hence, this could be an opening

for such discussions in the academic world. In case of executing such an approach, a considerable reduction of costs could be expected for Iranian oil and gas industry.

2. Materials and Methods

In this section, a brief introduction of virtual currencies studied in this paper has been given. Since the feasibility of their application is in question for Iran's oil and gas industry, a summarized jurisprudential perspective has also been provided. Afterwards, the methods and the indices used for TOPSIS model are defined.

2.1. Introduction of Virtual Currencies

Among more than 5000 virtual currencies introduced in the market, 5 were chosen according to their applicability as mentioned in the previous section (see Table 1). However, in order to move forward, a brief introduction for each one of them seems necessary. It should be noted that every virtual currency has its unique qualities and has been developed based on a need emerged in the market. Hence, although they could be supplementary for each other, their differences made them suitable for different applications. As for the oil and gas industry, the same concept could be applied, make the need for a deeper understanding of their nature more crucial. There are different kinds of virtual currencies which defined by the international organizations as stated below:

Bitcoin: a virtual currency scheme based on a peer-to-peer network. It does not have a central authority in charge of money supply, nor a central clearing house, nor are financial institutions involved in the transactions, since users perform all these tasks themselves. Bitcoins can be spent on both virtual and real goods and services. Its exchange rate with respect to other currencies is determined by supply and demand and several exchange platforms exist (Europe Central Bank, 2012).

Ethereum: Ethereum is an open source second-generation distributed ledger with an associated Turing-complete platform, that can be used to build and distribute decentralized applications. Ethereum will create its own blockchain. As of 2014, the project is still being built, although the test network is up and running (Franco, 2014).

Monero: Monero is a digital currency that offers a high level of anonymity for users and their transactions. Like Bitcoin, Monero is a decentralized peer-to-peer cryptocurrency, but unlike Bitcoin, Monero is characterized as a private digital cash (Frankenfield, 2019a).

Tether: Tether is a blockchain-based cryptocurrency whose cryptocurrencies in circulation are backed by an equivalent amount of traditional fiat currencies, like the dollar, the euro or the Japanese yen, which are held in a designated bank account. Tether tokens, the native tokens of the Tether network, trade under the USDT symbol (Frankenfield, 2019b).

BAT: BAT is short for Basic Attention Token; it is a digital advertising token which is built on the Ethereum blockchain. The purpose of the BAT token is to create an ad exchange marketplace which will connect the advertisers, publishers, and users in a decentralized manner. The purpose of BAT is to monetize user attention and remove all the other needless expenditure related to ad networks (Chadha, 2019).

In addition to the definitions given above, considering the Iranian community, nothing could be well-accepted unless the underlying roots of its religious state discussed. For this matter, in the coming subsection, this matter is briefly studied.

2.2. Jurisprudential Aspect of Virtual Currencies

Since the applicability of virtual currencies is being studied for the use in Iran's petroleum market, and considering the religious foundations necessary for any substitute in Iran's system, it seems necessary to briefly overview different aspects given on the matter. Virtual currencies are known to be a new emerging financial mean in the universal market whose fundamentals are needed to be studied more thoroughly by the researchers of the Jurisprudential fields. For any Fatwa¹ to be given on any matter, scholars spend so many years researching and studying, thus, as new as the virtual currencies, there still needs a couple of years for them to come out on the conclusion. However, meanwhile including such discussions in the related papers would be more helpful for the future Fatwas given on the matter. Any contradiction between the use of virtual currency as a financial substrate for transactions with the common sense of the religious instructions for the economics would result in a ban for using the virtual currencies, depriving Iran's oil and gas industry from a probable solution for its problems. Using virtual currencies in Iran requires no barrier from jurisprudential perspective and Islamic-based laws. Although numerous researches have been done to jurisprudentially investigate the use of virtual currencies, no conclusion and absolute unity has been formed as of yet.

According to Allameh's perspective, money has modality, contractual, hypothetical and credit aspect and does not deal with sensuality and money and also has not conceptual value. Therefore, one should not consider it as a good nor provide a market to supply and demand it. Bitcoin, hence, is compatible with money concept in Allameh's perspectives. Investigation of classic monetary approaches in the form of metalism, chartalism, money in circulation, and banking shows that Bitcoin, due to its special feature (peer-to-peer system), not only does not lack of any of money functions, but also, based on Allameh Tabatabai's perspective that validity of money is not only acceptable by confirmation of parties and verification of third party, gains its intrinsic value of description (Sobhani & Ghaemina, 2018).

It has to be noted that according to the results of jurisprudential investigation in other papers, there is feasibility of parties, references and disclosure in

¹ a ruling on a point of Islamic law given by a recognized authority



cryptocurrencies trade. Numerous problems stated about Bitcoin trade such as "money laundering", "Bitcoin currency bubble", "currency devaluation due to spreading in the country", "being deprived of money and commodity identity", "exchange of concept in trade", "falsifying of Bitcoin and placing the received money under receiving money through a wrong way", "gharar and danger of buying it", "loss of purchasers and public in case of cryptocurrencies trading" and "using cryptocurrencies in criminal orders and necessary to confront it because of behooove introduction and forbidding fault sustenance" are put away in case of subjective objections or not having current condition of trade regulations. Hence, one cannot prohibit cryptocurrencies trade such as Bitcoin by citing these reasons (Kheradmand, 2019).

However, by citing reasons such as no loss regulation, respect regulation, waste regulation and expedient regulation that all are forbidding the false monetary politics and essential change in volume of money, it is necessary that since government does not provide a regulation to control virtual currencies in real economy, legitimation of virtual currencies has to be prohibited to enter into the real world. Undoubtedly, presence of this money in its virtual societies, with no effects on order of real money, is legal and without problem. In contrast, if entrance of so-called virtual currencies to real world leads to phenomena such as change in volume of money, loss in other's belongings and anti-expedient phenomena such as exit of currency and facilitate to crimes, by citing these jurisprudential regulation that is mainly supervisor to governmental jurisprudence, one may declare a problem due to establishing Bitcoin in the country financial system from jurisprudential viewpoint (Soleimanipour et al., 2017). If once it is recognized that these currencies have been changed to tools for culprits to spread corruption or against dynamic economy and hurt it or provide delusive demand for world dominants currencies to continue predominance over wronged individuals, government may then adopt a proper address after realizing the secondary topics that requires a rule from jurisconsult (Kheradmand, 2019) and prior to confirm these issues,

one can use cryptocurrencies to strengthen Islamic government and to solve problems due to the sanctions.

Although some of the cryptocurrencies are free of drawback from personal jurisprudence and price decrees perspective, due to expressed dangers and risks in this section, they threat economy of the country and Muslims' capital and suffer of doubtful loss, therefore, using is not allowed from governmental jurisprudence, while some other cryptocurrencies such as national cryptocurrencies holding real support from gold or oil will not have these issues and due to its non-gavel nature and lack of publishing unsupported money, is closer to Islamic monetary system (Navvabpour, 2019).

Despite such analyses, one should say that using virtual currencies still suffers ambiguities and jurisprudential challenges from jurisprudential viewpoint.

2.3. Indices Mining and Ranking

In this subsection, the methodology of choosing the indices as well as TOPSIS method will be discussed in detail.

a. Indices mining

As aforementioned, for any application of virtual currencies, including petroleum market, various factors are in play. These many factors might have different impacts ranging from apparently small to very large ones. The choice among these many factors has to be carefully done, so as to include all the necessary aspects and study the range of impacts. Hence, for the present study, a process for choosing the indices was pursued (for details see Figure 3). Proceeding to gathering all the ideas according to the interviews and literature review, as the first step, they were presented to a focus group. The ideas were examined one by one and 8 indices were selected according to their priority. Indices were aimed to find out the capability of various currencies to be employed for international transactions. As for the verification, they were given to the experts of the field (will be discussed in section 3.3) and scored highly. The confirmed indices, then, were used in the TOPSIS method to rank the 5 most suitable virtual currencies.



Figure 3. Selection process of indices.

The mentioned indices are:

- Tradability in oil transactions: the capability of the currency to manage high oil prices and not highly fluctuating by selling and purchasing oil.
- Ability to hide: the ability to keep confidentiality and not being observed by others.
- Non-sanctioning mechanism: free from the supervision and domination of countries which are hostile toward Islamic Republic of Iran and goes in the category of the assets, which could not be, hold against the will of the owner.
- Liquidity: The ability of easily being exchanged to other common assets. One of the important issues for Iran's economy is returning cashes obtained from selling oil.
- Usability in oil chain supply: The possibility of purchasing goods by this currency. In oil production and upstream and downstream industries, it is often necessary to buy equipment from abroad.
- Transaction rate: The amount of time necessary for the approving of each transaction in the Blockchain ledger. It is natural that it would be more desirable as the rate of this process is higher.
- Global acceptance: The acceptability of the currency throughout the world and by different countries. The more global acceptability, the higher desirability.
- Price stability: the least possible fluctuation in the price of the virtual currency. To sell crude oil, the stability of price of virtual currency is necessary, which means that virtual currency does not fluctuate.

b. TOPSIS method

When we are dealing with different factors, there needs to be a method to identify and prioritize them. TOPSIS method is one of the most well-known methods in the field. It is a technique for order preference by similarity to ideal solution and proposed by (Hwang & Yoon, 1981). This approach is employed for four main reasons (García-Cascales & Lamata, 2012): a) TOPSIS logic is rational and understandable; b) the computation processes are straightforward; c) the concept permits the pursuit of the best alternatives for each criterion depicted in a simple mathematical form; d) the importance weights are incorporated into the comparison procedures. Therefore, it is the best choice for the current study.

TOPSIS method is a decision matrix composed of m rows and n columns, which contains m options with n criteria. TOPSIS is based on the notion that the preferred option should have the minimum distance from the positive ideal solution and should have the maximum distance from the negative ideal solution. TOPSIS considers the distance between the positive and negative ideals at the same time. Finally, the optimal solution, which has the minimum distance from the positive ideal and the maximum distance from the negative ideal, could be obtained (Opricovic & Tzeng, 2004).

The TOPSIS process is carried out as follows:

Step 1: mean experts' viewpoint

In this matrix, interest index has a positive desirability while cost index has a negative desirability. Create an evaluation matrix consisting of m alternatives



and n criteria, with the intersection of each alternative and criteria given as $(N_{ij})_{m \times n}$

$$n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^m (r_{ij})^2}} \quad (1)$$

Step 2: normalization or dimensionless matrix

We make the available indices dimensionless in this step in a way that each value is divided to vector size corresponding to that index.

Step 3: weighting to the normalized matrix

Decision matrix is actually parametric and it is necessary to be quantified. To do so, decision maker set a weight for every index. Weight sets are divided into normalized matrix

$$A^+ = \{ \min v_{ij} | j \in J_1 \} \cdot \{ \max v_{ij} | j \in J_2 \} | i = 1, 2, \dots, m \} \quad (2)$$

$$A^- = \{ \min v_{ij} | j \in J_1 \} \cdot \{ \max v_{ij} | j \in J_2 \} | i = 1, 2, \dots, m \} \quad (3)$$

Step 4: determination of positive and negative ideal solution

The two made virtual choices are actually the worth and the best solution.

$$A^- = (V_1 - , V_2 - , \dots , V_n -) \quad (4)$$

$$J_1 = \{ 1, 2, \dots, n | j \text{ is benefit} \} \quad (5)$$

$$J_2 = \{ 1, 2, \dots, n | j \text{ is worst solution} \} \quad (6)$$

Step 5: determination of distance from ideal positive and negative solution

We determine the distance among each option by the Euclidean method, which means we find distance of options from positive and negative ideal options

$$d_j^+ = \left\{ \sum_{i=1}^n (v_{ij} - v_j^+)^2 \right\}^{\frac{1}{2}} \quad (7)$$

Step 6:

Calculate the similarity to the worst condition:

$$d_j^- = \left\{ \sum_{j=1}^n (v_{ij} - v_j^-)^2 \right\}^{\frac{1}{2}} \quad (8)$$

$$C_i = \frac{d_i^-}{(d_i^- + d_i^+)} \quad (i = 1, 2, \dots, m) \quad (9)$$

3. Results and Discussion

In this section, first of all the problem of whether virtual currencies are suitable for petroleum transaction would be discussed. Smart contracts are one of the solutions provided for the utilization of virtual currencies. Various aspects of their pros and cons would be considered and according to the Iranian regulations for petroleum-related trades would be discussed. Afterwards, TOPSIS method will be applied and the results among different indices would be carefully analyzed.

3.1. The Volume of Petroleum Transactions vs. Virtual Currencies

One of the things that should be considered when studying on the feasibility of using virtual currency for Iran's petroleum transactions, is the volume of these markets. As already known, petroleum market has one of the largest volumes of transactions in the world (Grgitsidis & Delias, 2017). This might pose the question whether it is possible to transfer this large volume on the virtual currencies. However, the sanctions on Iran's economy bring too much pressure on the country and reduce petroleum exports to less than 2 million barrels a day. Although no official statistics has been published for the volume of Iranian Petroleum transactions, FRED (Crude Oil Exports for Iran, Islamic Republic of, 2020) reports an export of 400 thousands barrels a day which would be equal to 14 million dollars a day (considering 35 dollars a barrel as average) and sum up to 5110 million dollars annually. However, market values for the first three virtual currencies introduced in the present paper are \$24,250,522,446, \$9,581,979,268, and \$29,202,526,203 for Bitcoin, Ethereum, and Tether respectively (see Table 2). Daily volume of these transactions would sum up to 62 billion dollars, revealing a market almost 4600 times larger than today's market for Iranian petroleum. Even if we consider one single virtual currency like Bitcoin, it has a market 1700 times larger than the total volume of Iran's petroleum

transactions. Hence, there should be no problem in this regard.

Table 2. Volume of transactions for most known virtual currencies.

Virtual Currency	Volume of Transactions (Date:6 Jun 2020)
Tether	\$41,095,171,330
Bitcoin	\$33,994,059,031
Ethereum	\$12,900812,331
Monero	\$99,239,117
BAT (Basic attention token)	\$90,610,743

For more reliable analytics, let's consider the time of prosperity for Iran's economy which would have an export equal to 2 million barrels a day, 70 million dollars a day and an annual value of 25 billion dollars. Even in this case, the daily volume is less than the daily volume for Tether or Bitcoin. Moreover, analytics predict a real growth for the future volume of Bitcoin (SAHOO, 2017) and other virtual currencies which would enlarge the difference among the volume of petroleum transactions and virtual currencies, making them a suitable option for future trades. Although, as shown here, virtual currencies have the potential to handle all the petroleum trades of Iranian side, they still would be worth considering in any other case.

3.2. Smart Contracts

As stated before, virtual currencies have been chosen for their unique characteristics which could effectively solve the on-going problems in Iran's petroleum transactions. Since trading legally happens in the form of contracts, smart contracts have been developed for trading by virtual currencies. Smart contracts are a kind of contract that records terms with computer language instead of legal language (Welmans, 2019) which is one of the most important concepts in virtual currencies. On the one hand, because of the huge and complex nature of the oil and gas industry, long and

complicated contracts may arise in the trade of all parties, and the number of contracts will be considerable (in most cases each contract contains more than 500 pages). On the other hand, using smart contracts would help the environmentalists to save the planet, while recording every detail precisely and citably. In addition to that, petroleum contracts are normally signed for a future trade, meaning no oil tanker would leave the port before any agreements were made in the form of formal typical contracts (Chen, 2020). Smart contracts can partially solve this problem and due to their nature, speed up the process, meaning while the tankers are getting filled, they already have their buyers and destinations. This happens through an input transaction and input events which would lead to a preset response rule if the two were consistent with preset response conditions (Lu et al., 2019). Both of them would be recorded in the form of response in one of the blocks of the blockchain. As a matter of fact, the proposed system would check the consistency of both sides and suggest a connection among them, facilitating the trade and lowering the probability of humane errors in the process. This would effectively reduce time and costs and increase the efficiency of the system. Therefore, smart contract can not only greatly reduce paperwork, simplify the process, and improve efficiency, but also save costs (Lu et al., 2019). The process is illustrated in Figure 3.

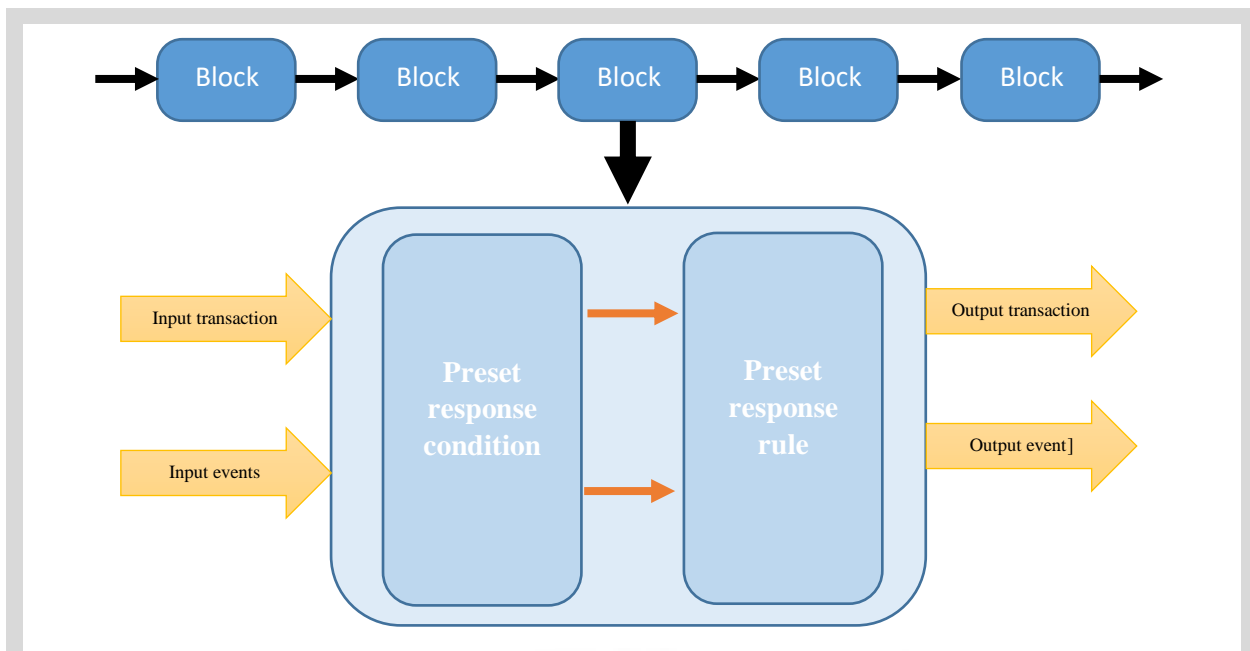


Figure4. Smart contracts process in brief.

According to NIOC mechanism for petroleum trades, credit and timing of payments are among the problems normally faced in the contracts. It is noted that payments should have no delay or failure and the buyers should be approved of a minimum credit, smart contracts, as aforementioned, could effectively reduce the risks, verify the trading parties and liquid the funds (Lu et al., 2019). Another justification for substituting normal contracts with the smart ones is their low cost. One of the major applications of blockchain in transactions is cross-border payments. Oil and gas are usually sold in large quantities, especially between countries, and the frequency of transactions is also high, which is different from the scale of transactions between banks. Virtual currencies (e.g. Bitcoin and Ether) can significantly reduce the cost of cross-border payments and consequently reduce the total expenses for both parties.

Although the transfer charge for virtual currencies is lesser than the bank transfer, it worth noting that it depends on two main factors: 1) the load on the bitcoin network, 2) the transaction fee which will be defined by the sender. The volume of money transfer requests sent on the Bitcoin network specify the load on the network. Since this volume would be different during the day (see Figure 4), required processing time for the transactions to be done would also differ ranging from a few minutes to a few days. For every transaction, a block needs to be created, taking at least 10 minutes for the process. As can be seen in Figure 4 which is developed based on the data taken on 5 Jun 2020, on the red spots (almost midnight), there are 170 pending requests which necessitates a 0.118 BTC transaction fee for an instant transaction.

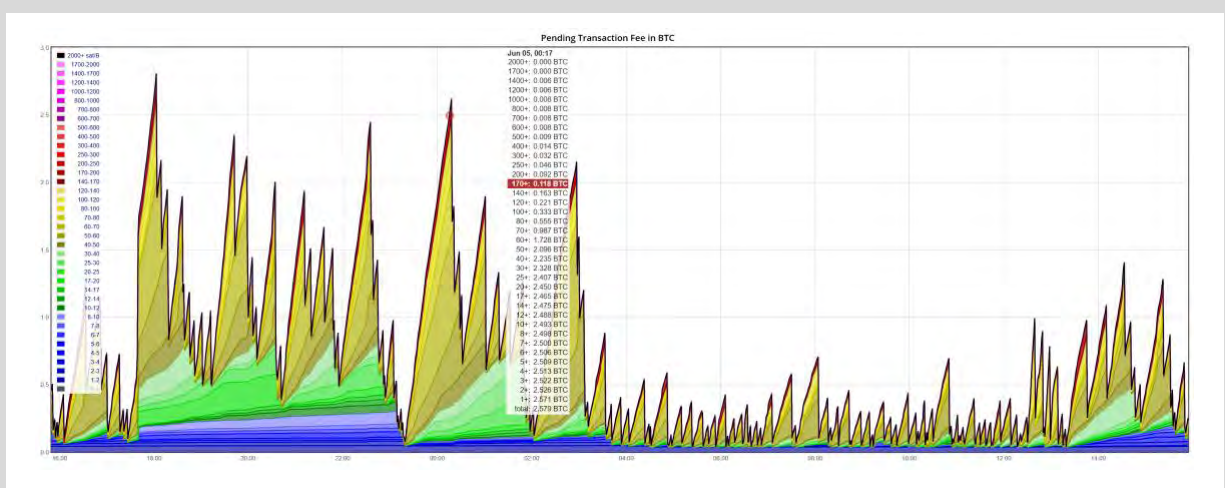


Figure 5. Pending transaction fees in BTC (hoenicke, 2020).

In addition to instant transfers, Smart contracts can also reduce the time required for intermediaries (Lu et al., 2019). This will eventually lead to an automated system for signing the agreements. As an application running in the Virtual Machines, the smart contract can receive transaction requests and events from outside, and generate new transactions and events by triggering the running code logic in advance (Lu et al., 2019). Such a mechanism would hugely reduce the time of contracts and increase the number of them to the full potential of every country. Both of which would be beneficial for the oil and gas industry. Hence, consideration of virtual currencies (i.e. smart contracts when it comes to the

contract terms) would be significantly advisable. This brings the research to the point that which one of the available virtual currencies is more suitable for such application. In the following subsections, TOPSIS method has been used to answer this question.

3.3. Demographic Information

Considering that the method used in this research (TOPSIS) is one of the expert-based methods, we referred to experts in this field to complete the questionnaire that their demographic information is written in Table 3.

Table 3. Expert information classification.

	Level of education	Energy / Oil related scientific fields	Energy / Oil related executive fields	Scientific and executive experience in the field of oil and energy	Scientific fields related to virtual currencies	Executive Areas Related to Virtual Currencies	Scientific and executive experience in the field of virtual currencies
Expert1	Ph.D..	Researcher	Analyst	2	Researcher /Virtual Currency Expert	-	3
Expert2	Ph.D.	Researcher	-	1	Researcher	-	5
Expert 3	Masters	Researcher	-	-	Researcher	Administration Manager/p olicymaker/ Trader	4
Expert 4	Ph.D.	Researcher	-	2	Researcher	-	1



	Level of education	Energy / Oil related scientific fields	Energy / Oil related executive fields	Scientific and executive experience in the field of oil and energy	Scientific fields related to virtual currencies	Executive Areas Related to Virtual Currencies	Scientific and executive experience in the field of virtual currencies
Expert 5	Ph.D.	Researcher	Head Consultant	7	Researcher	-	3
Expert 6	Ph.D.	Researcher	Consultant	6	Researcher	Administration Manager	4
Expert 7	Masters	Researcher	-	1	Researcher	policy maker /Trader	4
Expert 8	Masters	Researcher	Analyst	1	Researcher	policy maker	2
Expert 9	Masters	Energy expert	Analyst	1	Researcher	-	1
Expert 10	Ph.D.	Researcher	-	0.6	Researcher	policy maker	2.5
Expert 11	Masters	Researcher	-	0	Virtual Currency Expert	Trader	2
Expert 12	Ph.D.	Researcher	-	0.5	Researcher	policy maker	2.5

As discussed above, the present study needs two main field of expertise, i.e. virtual currencies and oil and gas transactions. Since the research has almost no competitive in the literature, not many of the experts in the field were graduated from Ph.D., however, to obtain reliable results, they had to be able to answer the questions both correctly and accurately. Therefore, about 60% of the selected experts have a degree of Ph.D. with an average of two-year experience in the oil and gas industry field and about three-year experience in the field of virtual currency. All of them were researching in the related field as of now and some of them were even among the consultants for either petroleum-related issues or virtual currency ones. While many might have knowledge in the field of petrochemical products,

petroleum market has a few experts of its own whom hold another level of expertise. Considering the point, all the experts were chosen from among those who have executive experience in the crude oil market, either as a manager, policymaker, analyst or consultant.

3.4. Analysis of Indices

The final step for coming to a conclusion and finding the best platform of virtual currencies for Iran's petroleum transactions was the analysis of indices. Through a careful consideration of the questioners, all the indices were examined for each and every one of the five virtual currencies suggested for this end. The results have been depicted in the form of graphs and will be discussed in detail in this subsection.

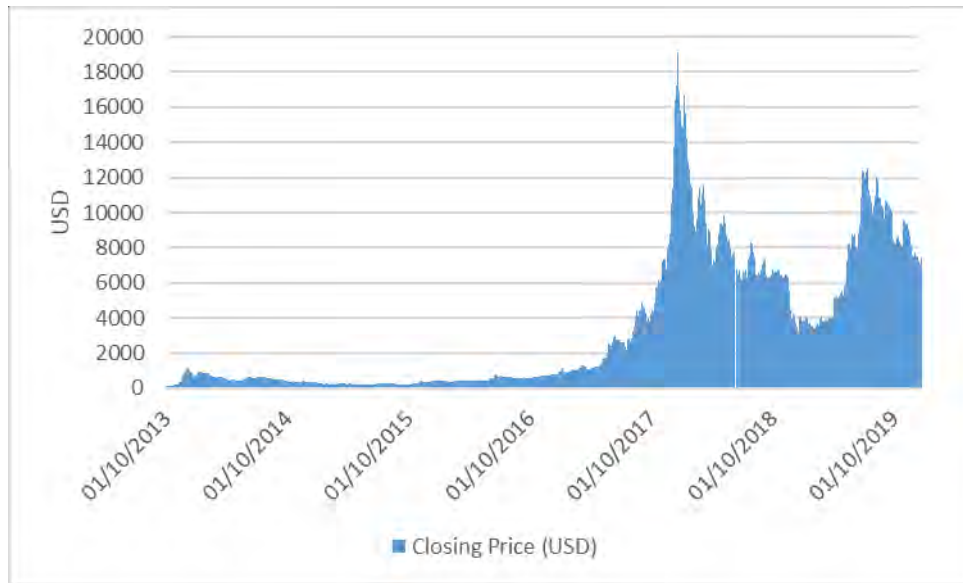


Figure 6. Bitcoin price from 2013 to 2019.

As can be seen in Figure 7, during the period of 2017 to 2018, Bitcoin prices fluctuates almost four times higher than its previous value. This shows that we cannot count on this asset. Since the cash flow from selling

petroleum should be transferred into something enjoying a store of value, it could be said that price's fluctuations are one of the most noticeable problems while considering bitcoin as the base value for selling petroleum.

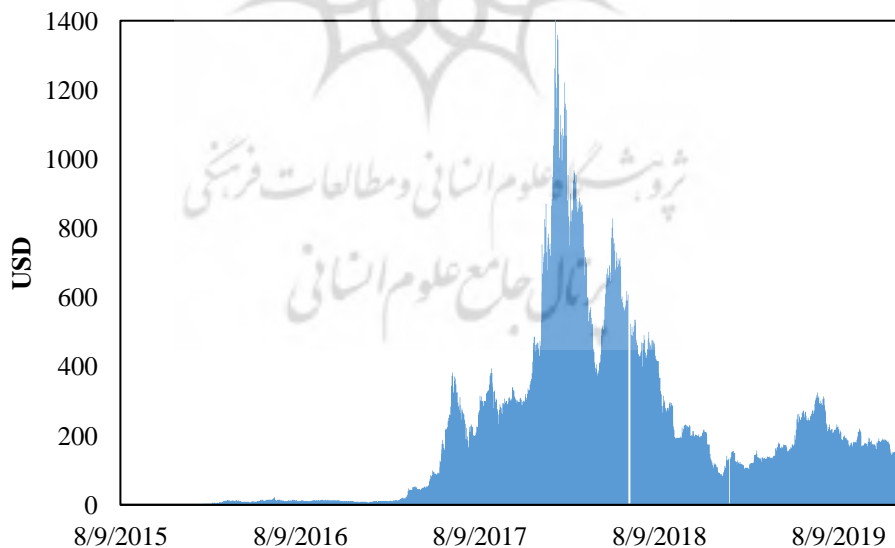


Figure 7. Ethereum price from 2015 to 2019.

Similar to Bitcoin, Ethereum has also severe price fluctuations, that has been grown more than 1000 times over a year, represented in Figure 4. Hence, the

abovementioned problems of Bitcoin would be still effective for Ethereum.

For the sake of the study, indices of appropriate virtual currency for selling petroleum have been



extracted by experts. Then, corresponding virtual currency has been verified by experts proportional to each index. Proceeding to which, experts assigned their own weight to every indice and ranked cryptocurrencies based on these indices. The designed indices were, then, equated and analyzed by TOPSIS method, and finally they were prioritized as shown in Table 3. Liquidity has gained the highest closeness index in this table, showing the most critical problem of selling petroleum which is the inability to change it into other assets (like gold, currency or other cryptoassets). Since the sanctions have

put a lot of limitations on the technologies necessary for oil supply chain, it was expected that the expansion and equipping of this chain gain a high rank in this table. However, unlike the expectations, usability of assets in supplying the oil supply chain has no priority compared to the other indices. Moreover, price stability, due to its tremendous effect even in minor fluctuations, was also anticipated to have a high rank in the table. It seems that the economy would suffer a lot when the market experiences an instability in the prices. Yet, the experts give a rank of fifth among the available indices.

Table 4. Prioritized indices according to the TOPSIS method.

Indices	closeness index
Liquidity	0/7809
Global acceptance	0/7491
Ability to hide	0/749
Non-sanctioning mechanism	0/7368
Price stability	0/5944
Exchange rate	0/4839
Positive Ability to trade in volume of oil transactions	0/4753
Usability in the oil supply chain	0/3196

Before addressing the results of the research, we need to examine the daily trade volume of virtual currency transactions. Since according to experts' ideas, the most important indices for using virtual currencies for selling petroleum is their liquidity potential, for a more thorough

investigation of the values, the worldwide ranking of these assets has been obtained based on this indice. As can be seen in Table 4, the most liquid virtual currency is Tether, bitcoin would rank the second, then Ethereum, and so on.

Table 5. Classification of the virtual currencies due to their liquidity (CoinMarketCap, 2020).

Virtual Currency	Day trade volume (Date: 18 Dec 2019)
Tether	\$32,674,028,633

Virtual Currency	Day trade volume (Date: 18 Dec 2019)
Bitcoin	\$26,949,902,887
Ethereum	\$11,323,062,540
Monero	\$106,664,401
BAT (Basic attention token)	\$65,536,086

If we combine the results obtained in Table 3 and Table 4, the first prediction for the best asset, would be Tether. However, final ranking of various structures of virtual currencies based on index for petroleum transactions is depicted in Table 5. Although there are numerous considerations in using various virtual currencies for petroleum transactions, the final results differ from our expectations. Bitcoin ranked first, while Tether goes into the third place. The most noticeable difference between these two assets, seems to be their global acceptance. Bitcoin is more known throughout the world, hence, it is more accepted by various parties. This would also be confirmed by Ethereum coming higher

than Tether in the table. Since not only it is more well-known worldwide, but also it has more capabilities comparing to Tether, which might be the reason for its superior popularity to Tether. However, their closeness index were so close which a slight change in the market might affect their places in the list.

One more noteworthy statement which could be drawn from the results, is the place of Monero and BAT asset, ranking similarly in both tables. The big gap between their closeness factor compared to the higher ranks, would confirm the importance of liquidity in prioritizing the assets.

Table 6. Experts' classification for virtual currencies.

Virtual Currency	Closeness index
Bitcoin	0/7479
Ethereum	0/6757
Tether	0/6418
Monero	0/3984
BAT	0

4. Conclusions

The impose of sanctions against Islamic Republic of Iran has brought many problems, especially in case of money transactions for any international trade made with

Iranian parties. Oil and gas industry were no exception for that which resulted in a fall in their volume by fifth. While some the proposed problems originates in the nature of money transactions through normal platforms, virtual currencies introduced a new way to overcome



typical unsolvable problems in the older platforms. However, among more than 5000 virtual currencies available in the market, the choice had to be carefully done to find the best suit for the petroleum transactions. The present research proposed 8 indices for realizing this goal and explored the possibility of using virtual currencies in Iran's petroleum transactions. The most suitable virtual currencies were ranked according to TOPSIS method while the pros and cons of them were discussed. The findings of the present paper are as follows:

- Since petroleum market size is one of the biggest markets in the world, the possibility of using virtual currencies were explored. Results show that considering the volume of virtual currencies transactions compared to Iran's petroleum transactions, the market size of virtual currencies is bigger by at least 1700 times than the current market of Iran's crude oil under sanctions.
- Even the consideration of a future growth for this market would still leave the market size of virtual currencies at least 3 times bigger than the petroleum market of Iran. This would be the case if predicted growth in virtual currencies market was to be ignored, which is unavoidable according to the experts of the field.
- As for Iran's religious-based system, the jurisprudential aspects were briefly explored. Yet, there needs more independent research on the issue for a result to come out. As far as the concern for this paper, using a virtual currency for petroleum transaction is neither forbidden nor advised.
- Considering NIOC mechanism for selling Iran's crude oil, many of the today's problems raised in these articles could be effectively solved through the available features of virtual currencies, i.e. smart contracts. This type of contract can help with the problems of credit of the buyers, instant transactions and on-time payments while reducing the expenses for both parties.
- 8 indices were introduced for study and advantaging from any virtual currencies for petroleum transactions. These indices are: Usability in the oil supply chain, Liquidity, Price stability, Global acceptance, Exchange rate, Ability to hide, Non-sanctioning mechanism, Positive Ability to trade in volume of oil transactions.
- Result shows that liquidity, global acceptance, ability to hide and non-sanctioning mechanism have the highest priority in finding the most

suitable virtual currency from the indices viewpoint respectively.

- For the petroleum transactions, results reveal that Bitcoin, Ethereum and Tether hold the first, second and third place as the most suitable platform respectively.
- It was expected that due to the price fluctuations of Bitcoin and Ethereum, they rank lower as not suitable for petroleum transactions, while BAT and Monero having less fluctuations were expected to be a better suit. However, the importance of Liquidity place Bitcoin and Ethereum among the best choices for this kind of transactions.

References

- Abdi, M. J. (1385). History of Oil Embargo and Oil Weapons.
<https://www.magiran.com/article/1040267>
- Azadi, P., Dehghanpour, H., & Madani, K. (2016). The Future of Iran's Oil and Its Economic Implications.
<https://purl.stanford.edu/mp473rm5524>
- Balas, E. (2012). The Strategic Petroleum Reserve: How Large should it be? In B. A. Bayraktar (Ed.), Energy Policy Planning (pp. 335–386). Springer.
[https://books.google.com/books?hl=en&lr=&id=ASDIBwAAQBAJ&oi=fnd&pg=PA1&dq=B.+A.+Bayraktar,+Energy+Policy+Planning+\(2012\),+p.+340.&ots=mEl-YRNzGa&sig=dwsiaZaRSZ-vFppo2H7AQAtYWZw#v=onepage&q&f=false](https://books.google.com/books?hl=en&lr=&id=ASDIBwAAQBAJ&oi=fnd&pg=PA1&dq=B.+A.+Bayraktar,+Energy+Policy+Planning+(2012),+p.+340.&ots=mEl-YRNzGa&sig=dwsiaZaRSZ-vFppo2H7AQAtYWZw#v=onepage&q&f=false)
- Bitdegree. (2020). Various Types of Cryptocurrency: How Many Cryptocurrencies are There?
<https://www.bitdegree.org/tutorials/types-of-cryptocurrency/>
- Chadha, B. (2019). What is Basic Attention Token (BAT)? . https://blockgeeks.com/guides/what-is-basic-attention-token/#What_is_Basic_Attention-Token_BAT
- Chen, J. (2020, April 21). Crude Oil Definition. Investopedia.
<https://www.investopedia.com/terms/c/crude-oil.asp>
- CoinMarketCap. (2020). All Cryptocurrencies. CoinMarketCap.
<https://coinmarketcap.com/all/views/all/>
- Crude Oil Exports for Iran, Islamic Republic of. (2020, April 15). FRED.
<https://fred.stlouisfed.org/series/IRNXXGOCMBD>

- Europe Central Bank. (2012). Virtual Currency Schemes. In European Central Bank. <https://doi.org/ISBN:978-92-899-0862-7> (online)
- Franco, P. (2014). Understanding Bitcoin. In Understanding Bitcoin. <https://doi.org/10.1002/9781119019138>
- Frankenfield, J. (2019a). Monero Definition. <https://www.investopedia.com/terms/m/monero.asp>
- Frankenfield, J. (2019b). Tether (USDT). <https://www.investopedia.com/terms/t/tether-usdt.asp>
- García-Cascales, M. S., & Lamata, M. T. (2012). On Rank Reversal and TOPSIS Method. *Mathematical and Computer Modelling*, 56(5–6), 123–132. <https://doi.org/10.1016/j.mcm.2011.12.022>
- Grgitsidis, F., & Delias, P. (2017). A Performance Measurement System for Staff of the Logistics Section: A Case Study for an Oil and Gas Company. In N. Sykianakis, P. Polychronidou, & A. Karasavoglou (Eds.), *Economic and Financial Challenges for Eastern Europe* (pp. 27–46). Springer. [https://books.google.com/books?id=pAGiDwAAQBAJ&pg=PA28&lpg=PA28&dq=the+largest+volume+products+of+the+industry+are+fuel+oil+and+gasoline+\(petrol\)&source=bl&ots=z5KLB5AjBe&sig=ACfU3U2hDCyoCM4D2nYxq3L1suABmzBg8A&hl=en&sa=X&ved=2ahUKEwj-7NTAy_zpAhUKCewKHWCKDk4Q6AEwBHoECBEQAQ#v=onepage&q=the+largest+volume+Products+of+the+Industry+are+Fuel+Oil+and+Gasoline+\(petrol\)&f=false](https://books.google.com/books?id=pAGiDwAAQBAJ&pg=PA28&lpg=PA28&dq=the+largest+volume+products+of+the+industry+are+fuel+oil+and+gasoline+(petrol)&source=bl&ots=z5KLB5AjBe&sig=ACfU3U2hDCyoCM4D2nYxq3L1suABmzBg8A&hl=en&sa=X&ved=2ahUKEwj-7NTAy_zpAhUKCewKHWCKDk4Q6AEwBHoECBEQAQ#v=onepage&q=the+largest+volume+Products+of+the+Industry+are+Fuel+Oil+and+Gasoline+(petrol)&f=false)
- Hache, E., & Massol, O. (2016). Sanctions Against Iran: An Assessment of their Global impact through the Lens of International Methanol Prices.
- hoenicke, jochen. (2020). Johoe's Bitcoin Mempool Size Statistics. <https://jochen-hoenicke.de/queue/#0,24h>
- Hwang, C.-L., & Yoon, K. (1981). *Methods for Multiple Attribute Decision Making* (pp. 58–191). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-48318-9_3
- Iran to Accept Payment in Gold for oil. (2012, February 29). BBC News. <https://www.bbc.com/news/business-17203132>
- Kameli, A. (2009). Mechanism of Crude Oil Tradings in Physical Markets. *Institute for International Energy Studies*, 68–69.
- Kheradmand, M. (2019). A Juridical Investigation of Mining and Exchanging Crypto-currency, Focusing on the Bitcoin Network. *Ma'rifat-e Eghtesad-e Islami*, 10(2), 109–124.
- Lu, H., Huang, K., Azimi, M., & Guo, L. (2019). Blockchain Technology in the Oil and Gas Industry: A Review of Applications, Opportunities, Challenges, and Risks. *IEEE Access*, 7(April), 41426–41444. <https://doi.org/10.1109/ACCESS.2019.2907695>
- Mahdavy, H., & Cook, M. (1970). The Patterns and Problems of Economic Development in Rentier States: the Case of Iran. *Life*, 1.
- Marvi, A., & Shayesteh, A. (1394). Economic Sanction, Evaluation of Economic Sanction in the World, Economic Sanction and Post-Sanction on Iran.
- Mazeel, M. (2010). Definition and Classification of Petroleum Fiscal System. In *Worldwide Petroleum Fiscal System* (pp. 38–64).
- Milano, A. (2018). China's Sinochem Completes Gasoline Export Over Blockchain System - Milano, A. (2018). China's Sinochem Completes Gasoline Export Over Blockchain System - CoinDesk. <https://www.coindesk.com/chinas-sinochem-completes-gasoline-export-over-blockchain-systemC>. <https://www.coindesk.com/chinas-sinochem-completes-gasoline-export-over-blockchain-system>
- Narula, K. (2018). Role of Energy Markets. In *The Maritime Dimension of Sustainable Energy Security* (pp. 82–89). https://books.google.com/books?id=U_xlDwAAQBAJ&pg=PA89&lpg=PA89&dq=crude+oil+price,+the+term+of+the+contract,+its+security,+and+transparency+of+the+transactions&source=bl&ots=5kk0DSg2kD&sig=ACfU3U3YP_1sKkFXBbFdamKpRChXf0mHEQ&hl=en&sa=X&ved=2ahUKEwjrmu3i8_zpAhUE_aQKHU-eD-kQ6AEwAHoECAcQAQ#v=onepage&q=crude+oil+Price%2C+the+Term+of+the+Contract%2C+its+Security%2C+and+Transparency+of+the+Transactions&f=false
- Navvabpour, A. (2019). Jurisprudential Analysis of Cryptocurrencies' Functions. Imam Sadegh University.
- NIOC International Affairs. (2020). Crude Oil Registration. [https://www.nioc-intl.com/\(X\(1\)S\(2mu1eaqsz4t04c4y3kth55\)\)/EN/CrudeReg.aspx?AspxAutoDetectCookieSupport=1](https://www.nioc-intl.com/(X(1)S(2mu1eaqsz4t04c4y3kth55))/EN/CrudeReg.aspx?AspxAutoDetectCookieSupport=1)
- Nouri, M., & Navvabpour, A. (2018). Conceptual Framework Designing of Virtual Currencies



- Policy in Iranian Economy. *Public Policy*, 3(4), 51–78.
- Opricovic, S., & Tzeng, G. H. (2004). Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS. *European Journal of Operational Research*, 156(2), 445–455. [https://doi.org/10.1016/S0377-2217\(03\)00020-1](https://doi.org/10.1016/S0377-2217(03)00020-1)
- Rajabi, A. (2019). Extraction of Cryptocurrencies and the Monitoring Role of Islamic Parliament of Islamic Republic of Iran.
- SAHOO, P. K. (2017). Bitcoin as Digital Money: Its Growth and Future Sustainability. *Theoretical and Applied Economics*, 24(4), 53–64.
- Schaik, J. Van. (2012). How Governments Sell Their Oil. April, 1–9.
- Sobhani, H., & Ghaemina, A. A. (2018). A Reflection on the Origin of Bitcoin Value from the Viewpoint of Allameh Tabataba'i (RA). *Economic Research*, 70, 245–263.
- Soleimanipour, M. M., Soltaninejad, H., & Pourmotahhar, M. (2017). Jurisprudential Investigation into Virtual Money. *Islamic Financial Research*, 12(2), 167–192.
- Verdier, P.-H. (2020). Global Banks on Trial: U.S. Prosecutions and the Remaking of International ... - Pierre-Hugues Verdier - Google Books. [https://books.google.com.ua/books?id=P93QDwAAQBAJ&pg=PA122&lpg=PA122&dq=Iranian+oil+export+has+decreased+to+less+than+2+million+barrels+in+March+2012+due+to+these+sanctions.&source=bl&ots=B5KXmX0SPv&sig=ACfU3U37A98iKv_n9glv3ptUpaYMxR6p2g&hl=en&sa=X&ved=2ahUKEwjX-PCmw_LpAhXOGewKHS3BCf0Q6AEwAXoECA0QAQ#v=onepage&q=Iranian oil export has decreased to less than 2 million barrels in March 2012 due to these sanctions.&f=false](https://books.google.com.ua/books?id=P93QDwAAQBAJ&pg=PA122&lpg=PA122&dq=Iranian+oil+export+has+decreased+to+less+than+2+million+barrels+in+March+2012+due+to+these+sanctions.&source=bl&ots=B5KXmX0SPv&sig=ACfU3U37A98iKv_n9glv3ptUpaYMxR6p2g&hl=en&sa=X&ved=2ahUKEwjX-PCmw_LpAhXOGewKHS3BCf0Q6AEwAXoECA0QAQ#v=onepage&q=Iranian%20oil%20export%20has%20decreased%20to%20less%20than%202%20million%20barrels%20in%20March%202012%20due%20to%20these%20sanctions.&f=false)
- Welmans, T. (2019). Blockchain applications in energy trading | Deloitte UK. <https://www2.deloitte.com/uk/en/pages/energy-and-resources/articles/blockchain-applications-in-energy-trading.html>
- Zamani, M. (1385). Analysis of the international structure of the crude oil market. *Quarterly Energy Economics Review*, 9, 58–76.

