

Oil crisis of 2020: Application of the DMAIC methodology

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Abstract - The May futures contracts for West Texas Intermediate (a specific grade of crude oil) fell into negative territory for the first time in history in mid-April, causing one of the biggest crises the oil industry has ever seen. The decrease in demand for oil due to the onset of the coronavirus pandemic coupled with a surplus of stock and various political factors resulted in sellers of oil paying buyers to get the commodity off their hands. This research paper presents an application of the Six Sigma methodology DMAIC (Define, Measure, Analyze, Control, Improve) to the oil crisis. The DMAIC methodology is frequently used in industries to improve and optimize existing processes. Through the DMAIC approach and its complementary tools we attempt to measure the oil consumption around the globe post the coronavirus pandemic, analyze the impact of the oil crisis and its root causes, discuss improvements suggested by the G20 countries to abate the crisis and check the implementation of the suggested measures and provide a control plan to determine the possibility of such a crisis beforehand.

Key Words: Coronavirus Pandemic, West Texas Intermediate, Oil crisis, Six Sigma, DMAIC

1. INTRODUCTION

The volatility of oil as a commodity has never been a surprise, however, the recent oil crisis has been regarded as the worst the industry has ever seen with the energy sector. It became the second smallest segment in the S&P 500 index with weighting down by 80%. Since the start of 2020, the world has been facing one hurdle after another, with the coronavirus seemingly being the most difficult of them. The coronavirus pandemic has brought upon us unprecedented circumstances. The lockdown imposed by all the affected countries has resulted in a huge drop in demand for oil. Despite the huge drop in demand, there was an increase in oil production due to various political factors, which resulted in oil futures of WTI (West Texas Intermediate – a specific grade of crude oil sourced from Cushing, Oklahoma) entering into negative territory on April 20 as there wasn't enough space to store this excess oil.

2. BACKGROUND OF THE OIL INDUSTRY

2.1 Oil market

From Industries to domestic uses, oil is one of the most used sources of energy in the world. Despite shifting trends to green energy, the demand for crude oil around the world is inexorable in modern-day. Since the 1950s oil has become the lifeblood of the global economy. Crude oil is a globally traded commodity, thus making factors like supply and demand playing a huge role in determining prices. Even though relatively very few companies are into the production of crude oil, the crude oil market is still very sustainable and global. It is very common for oil traders to shift towards the markets with high prices. In 2020, almost half of the world's oil production is from only three nations: The United States, Russia, and Saudi Arabia.

With 2019 global GDP estimated to be \$86 trillion, the oil and gas drilling sector alone makes up around 3.8% of the global economy [3]. The crude oil market is a global market in which most of the transportation is done through supertankers in water. On a broader scale, Oil prices are mainly dependent on supply and demand, and events across the world. A supplier can bring movement in prices by producing a large amount of oil or by withholding supply.

2.2 Organization of the Petroleum Exporting Countries (OPEC)

Organization of the Petroleum Exporting Countries (OPEC) founded in 1960 is a permanent intergovernmental organization formed by Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. These countries were later joined by other countries making 13 active members in 2020. OPEC was formed mainly to stabilize the prices and regulate the supply of petroleum to consuming nations. OPEC members state possessed 81.89% of crude oil reserves in the world according to its annual statistical bulletin of 2018 which makes them important organization in the Oil industry. The primary objectives of OPEC as an international institution are:

- Co-ordinate and unify the petroleum policies of the member countries and to determine the best means for safeguarding their individual and collective interests,
- Seek ways and means of ensuring the stabilization of prices in international oil markets, with a view of eliminating harmful and unnecessary fluctuations. [3]

2.3 OPEC+

After the growth of United States shale oil production making it one of the top nations producing crude oil. OPEC+ is formed by an amalgamation of Nations like Russia, Mexico, and Kazakhstan and OPEC members, combined all these nations control over 50 percent of global oil supplies and about 90 percent of proven reserves [3]. This makes OPEC+ a key player in the global economy with capabilities to bring movement in oil prices at any time.

2.4 The Determinants of Oil Prices

Crude oil being a global commodity, the factors which influence the prices are also global. While no single factor dominates but mainly two factors impact the prices:

- Supply and Demand
- Market sentiment

The concept of supply and demand is very straightforward where suppliers can flood the market with excess supply to bring a decline in prices and holding to bring the upside trend in prices. Events across the world can bring movement in prices like political unrest between nations, or war.

Oil is traded mainly in the “Spot” or “Forward” market. Spot prices for a commodity are more like prices at the time of physically exchanging the commodity and Forward or future is a contract that gives right to trade oil at a predefined price in predefined time in future.

The other key factor in oil prices is sentiments, the belief that oil demand will increase in the future can bring a huge upside movement in oil prices in present, the opposite is also true.

In terms of statistical regularities, the paper notes that changes in the real price of oil have historically tended to be (1) permanent, (2) difficult to predict, and (3) governed by very different regimes at different points in time.[2]

2.5 Crude Oil Benchmark

In reality-based on factors like density, viscosity, consistency, Sulphur content, and geographical location crude oil is categorized in different baskets called benchmarks around the world. The Energy Intelligence Group has identified 161 different blends in total traded on the market these days

There are three different types of benchmarks, namely:

- North America’s West Texas Intermediate Crude (WTI)
- North Sea Brent Crude (Brent)
- OPEC Reference Basket (ORB)

2.5.1 West Texas Intermediate (WTI)

It comes from the Southwestern United States. WTI benchmark crude oil is superior in quality as better gasoline can be refined from a single barrel compared to other crude oils, making it high in demand largely in gasoline consuming nations.

2.5.2 Brent Crude

Brent comes from the North Sea. Brent Crude is a major trading classification of sweet light crude oil that serves as a major benchmark price for purchases of oil worldwide. Brent Blend is actually a combination of different oils from 15 fields throughout the Scottish Brent. The Brent field is located in the East Shetland Basin, halfway between Scotland and Norway. Brent Blend is quite excellent for making gasoline and middle distillates.

2.5.3 OPEC Reference Basket (ORB)

ORB is the weighted average crude oil price for OPEC members. OPEC Basket is the pricing data formed by collecting seven crude oils from the OPEC nations (except Mexico). The OPEC Basket, including a mix of light and heavy crudes, is heavier than both Brent crude oil, and West Texas Intermediate crude oil.[5]

Other well-known blends include:

- Dubai and Oman or (Oman (sour),
- Tapis Crude (which is traded in Singapore),
- Bonny Light (used in Nigeria),
- Mexico’s Isthmus

3. DMAIC

DMAIC which stands for Define, Measure, Analyze, Improve, Control is a common Six Sigma methodology used in industries to optimize and improve processes. DMAIC is a data-driven quality strategy used to improve processes. It is an integral part of a Six Sigma initiative, but in general, it can be implemented as a standalone quality improvement procedure or as part of other process improvement initiatives. Each of the phases has the following objective [Fig -1]:

Define: The define phase serves the objective of defining the problem statement.

Measure: The measure phase is used to measure process performance.

Analyze: This phase helps in determining the root causes which led to the occurrence of variation and poor performance.

Improve: The improve stage addresses the causes identified and analyze phase and works towards improving them.

Control: To avoid a similar problem in the future we implement the control phase.

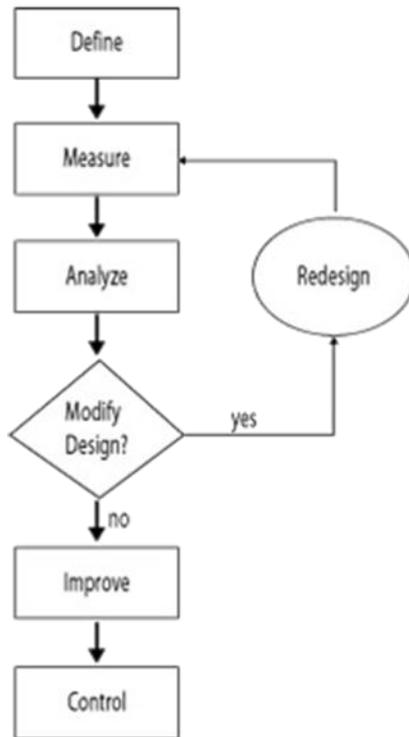


Fig -1: The DMAIC Methodology

However, it should be noted that DMAIC is not unique to Six Sigma and can be used for other improvement applications as well.

With the help of this paper, an attempt was made to explore how the DMAIC methodology combined with Six Sigma tools can be applied to the oil crisis of 2020, taking into consideration the different causes which acted as precursors to this crisis, the impact that the crisis had, and what does the scenario look like as we near the end of the first half of 2020. With the help of the Six Sigma methodology DMAIC and its supplementary tools, the paper attempts to find out the primary causes which led to this crisis and how the different oil-producing nations are working towards solving this problem and what steps should be taken in the future to avoid such a crisis.

4. LITERATURE REVIEW

The oil crisis of 2020 came as a shock to the whole world. Although the glut in oil supply was predicted, the influence that it would have was unfathomable. To understand the oil crisis a brief on the oil industry is necessary - the early oil production, the key players, the challenges, and the booms and busts [1]. Hamilton, J.D. Explained the behavior of oil prices and the features of petroleum demand and supply [2]. The three sectors of oil industry (Upstream, middle stream and Downstream) and exploration and production in global oil industry were studied [3]. John, Emmanuel gave an understanding of OPEC (Organization of Petroleum Exporting Countries - the cartel of oil industry), since its foundation and its framework for operation [4]. Crude oil is a commodity which is produced all around the globe, and thus to categorize it into different baskets for the ease of trade different benchmarks were identified. Harraz, Hassan explained the difference between different benchmarks of oil and their importance in global crude oil market [5]. Data is an integral part in the process of research as it is the guiding beacon in the process, a regulated and accurate data was provided by the International Energy Agency's Oil Market Report (OMR). OMR delivered a comprehensive and authoritative analysis on the global oil market with detailed statistics on oil supply, demand, prices, inventories and refining activity [6]. Jodi Oil World Database provided a compiled dedicated chart book of timely information on oil inventory data [7]. Kolochi, Prabu et al reported the impact and implementation of DMAIC phases of Six Sigma through a case study [10]. The International Energy Agency (IEA) released a report titled which made clear the role of coronavirus in the crisis [11]. Furthermore, the April and May reports released by the IEA were referred and emphasized the measures taken by the oil producing countries to tackle the crisis [12] [13]. To implement each phase of DMAIC process, understanding the impacts of crisis in general on consumers is indispensable [14]. A crisis of such an extent has affected the industry [15] to the core. A right partition between the general perception and which economies were actually affected by the crisis is resolved [16]. With all these resources the DMAIC methodology has been applied to the oil crisis of 2020.

5. METHODOLOGY

5.1 Define

Every oil crisis that has taken place till date can be traced back to three root causes [18], and these are:

- Decrease in Demand
- Increase in Supply
- The monopoly power of oil producers falls

In the case of the oil crisis of 2020, all three factors listed above acted as precursors provided below:

During November of 2019, there was an outbreak of the coronavirus in China. By the end of the First Quarter of 2020, the coronavirus epidemic had turned into a pandemic. With the spread of the virus, many countries started imposing lockdown, thus preventing people from going outside their homes, except for getting essential supplies. China which is the largest importer of oil was one of the first countries to impose a lockdown, this resulted in closed factories and reduced transport services. All these factors together caused a 'Decrease in Demand'.

To tackle the decrease in demand, an ideal solution would have been to reduce supply. However, in reality, the U.S, Saudi, and Russian oil producers continued pumping oil at the same rate. This caused an 'Increase in Supply', with no available space to store this excess oil.

A price war between Russia and Saudi Arabia further aggrandized the issue. This resulted in the 'Monopoly of oil producers to fall'.

All these factors combined caused one of the biggest oil crises, whose impacts will be felt throughout 2020.

5.2 Measure

The purpose of this phase is to measure the process performance which can be achieved in the following ways

- Find out the major oil producers over the past decade using the Pareto analysis [Chart 1].
- Compare the crude oil consumption before and after the first quarter of 2020 using graphical analysis.

Pareto analysis of oil production by country for the years 2010 & 2020

Analysis of Oil producing countries around the world for 2010 shows 16 countries contributed towards 80% of production including major contributors Russia, Saudi Arabia, and U.S.

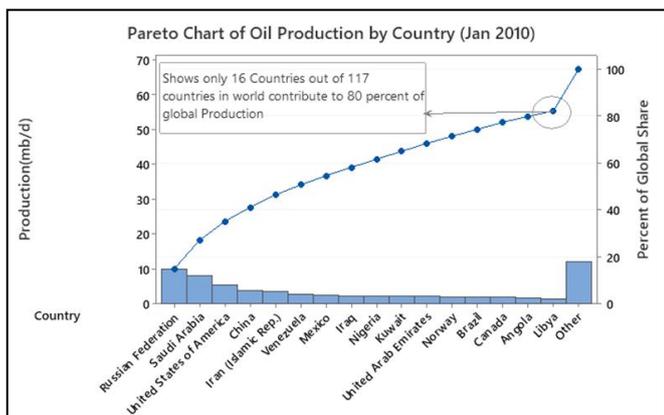


Chart -1: Pareto chart of oil production by country (Jan 2010)

Table -1: List of countries by oil production (January, 2010)

Country	% of Global Production	Cumulative %
Russia	15	15
Saudi Arabia	12	27
USA	8	35
China	6	41
Iran	5	46
Venezuela	4	50
Mexico	4	54
Iraq	4	58
Nigeria	4	62
Kuwait	3	65
United Arab Emirates	3	68
Norway	3	71
Brazil	3	74
Canada	3	77
Angola	3	80
Libya	2	82

In the past decade, the United States surpassed Russia and Saudi Arabia to become the world's largest crude oil producer. U.S. crude oil production exceeded that of Saudi Arabia for the first time in more than two decades. According to analysis, it shows the United States, Russia, and Saudi Arabia cumulatively produce 48.9% of the world's crude oil production. This shows how large these three nations can influence the global crude oil market.

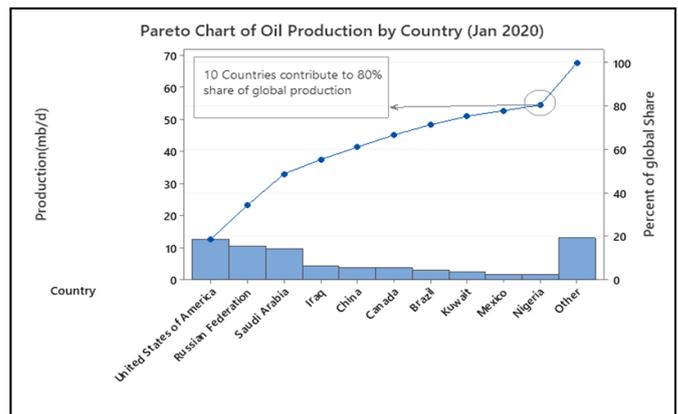


Chart -2: Pareto chart of oil production by country (Jan 2020)

Table -2: List of countries by oil production (January, 2020)

Country	% of Global Production	Cumulative %
USA	18.8	18.8
Russia	15.7	34.5
Saudi Arabia	14.4	48.9 (First 3 countries produce almost half of

		world share)
Iraq	6.6	55.5
China	5.7	61.2
Canada	5.6	66.8
Brazil	4.7	71.5
Kuwait	3.9	75.4
Mexico	2.6	78
Nigeria	2.6	80.6

5.2.1 Graphical analysis for comparison of crude oil consumption before and after the first quarter of 2020.

Global oil demand declined as the pandemic made people around the world stay indoors and avoid unnecessary travel. Around 3rd and half of the population were under lockdown which drastically reduced crude oil consumption.

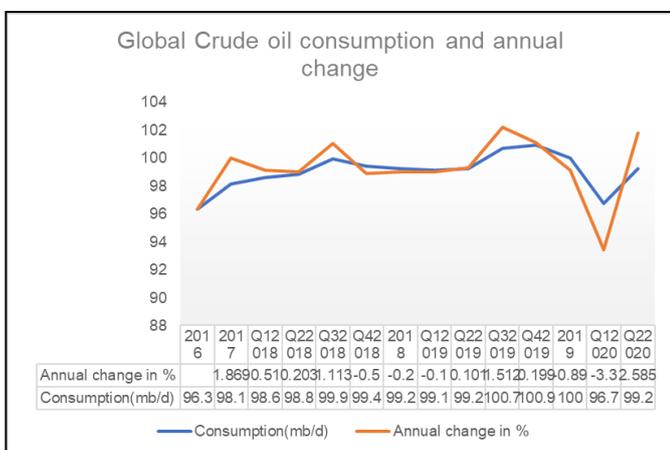


Chart -3: Global crude oil consumption and annual change

According to the report from IEA global oil consumption for the year 2019 was 100.2 mb/d which declined to 96.7 mb/d in March 2020, a fall of 3.5 mb/d for the first time since 2009[6].

5.3 Analyze

The ‘measure’ phase, gives an overview of the changes that occurred between the first and second quarter of 2020 with regards to oil consumption and production. The analyze phase will serve the purpose of finding out the root causes, using the Fishbone diagram [Fig -2].

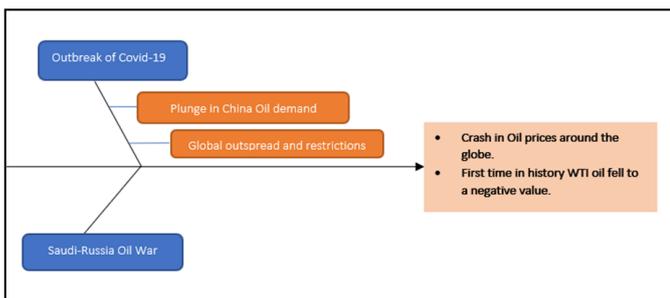


Fig -2: Root cause analysis

5.3.1 Impacts

The oil industry in the past decade or two has vastly proliferated in the United States, a drop in oil prices 10 or 20 years ago would have actually benefitted the economy as it would have reduced energy cost. But the oil industry today employs close to 10 million people either directly or indirectly and the oil crisis is going to have a resounding effect on industries other than oil such as manufacturers of pipelines, or oil drilling equipment [23].

Table -3: Impact Overview

SR. NO.	Who was affected?	What were the effects?
1	People employed in oil and its auxiliary sectors.	The data from Bureau of Labor Statistics (BLS), revealed that 84,098 people have already lost their jobs in the oilfield equipment and service sector until the end of May [22].
		Close to 1 million people employed in the oilfield services will be left jobless by the end of the year, which represents roughly a 21% reduction in the global oilfield equipment and service industry (OFS).
		13% of the projected job cuts will be due to the drop in oil prices while the remaining 8% will be more directly linked to the novel coronavirus.
		Employment in the OFS sector has declined by 13.5% from May of 2019 to May of 2020 [26].
2	Consumers of oil - Layman	A price drop in oil future contracts will not necessarily result in a price drop at the local gas station, so the crisis will not have a direct impact on the consumers of oil [14].
3	Oil Industry	Before the advent of the coronavirus, the U.S operated close to 650 rigs, but after the oil crisis it is now down to 378 working rigs, which is more than a 40% reduction.
		The oil producers of U.S have closed more than 6,000 wells and curtailed about 405,000 barrels a day in production which is 30% of the state's total output.
		Russia confirmed their delivery of flagship Ural oil would drop to a

		10 year low in May.
		Countries like Africa, Vietnam and Brazil are reducing their daily output or at least making plans to do so.
		The supply chain of oil refining, freight and storage is starting to seize up so there is no way to push this already underpriced oil into the market.
		The prices available to producers of oil in Western Canada have fallen as low as single digits and there have been reporting's of negative oil price for some grades in parts of North America [15].
4	Oil refiners	Marathon Petroleum Corporation, one of the biggest oil refiners of U.S announced it is stopping production at a plant near San Francisco [23]. Many refineries across Asia and Europe are working at half their capacities with U.S oil refiners clocking in their lowest processing of oil in the past 30 years [11].
5	Energy Sector	A transition to clean energy sources which had recently begun will be hindered due to the drop in oil price. Oil and gas have known to go hand in hand, as is the case of many long-term gas contracts and a drop in oil prices will sooner or later result in a drop in natural gas contract prices. Possibility of a reduction in gas production. Suppliers with the highest short-term costs of production and those who rely on spot sales are among the most vulnerable [11].
6	Small scale oil producers	Most vulnerable to this crisis are the smaller oil producers such as those of Ecuador. Oman is also going through a similar situation with rising debts, while Nigeria has applied for emergency funds. Iraq which is already in a state of political turmoil is facing cut backs

		in oil revenue.
		The plunge in oil prices is just another blow for Venezuela, a country struggling with hyperinflation [16].

If the oil price through 2021 averages to be \$30 a barrel the budget deficits of many countries will become far more severe.

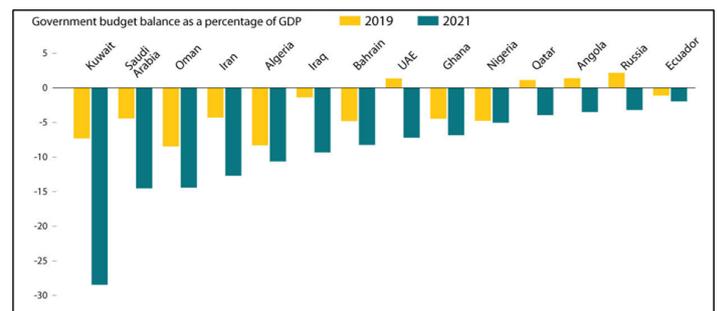


Fig -3: Government budget balances as a percent of GDP.

5.4 Improve

From the 'analyze' phase of DMAIC the primary causes which led to the crisis were identified as:

- ☒ Drop in Demand
- ☒ Surplus stock due to increased supply
- ☒ Russia -Saudi Arabia price war

A regression analysis was performed in order to determine the effect of the primary causes on the spot price of oil. For this purpose, the price of oil for the past 15 months was collected. It is evident that political factors cannot be quantified hence they are not included in the regression analysis.

Available Data [7][35]

Table -4: Reference data for regression

Oil spot price (EUROPE) – Brent (Y)	Total quantity imported (Kb/d) (X ₁)	Total quantity produced (Kb/d) (X ₂)
\$63.96	46657.2536	67526.164
\$66.14	44446.6183	66983.5108
\$71.23	47871.2574	66092.5836
\$71.32	44097.9794	66962.0358
\$64.22	75889.76	67182.0955
\$63.92	45431.5642	65687.4076
\$59.04	45682.2931	66687.606

\$62.83	42851.7551	67176.4481
\$59.71	44369.3293	68313.5324
\$63.21	45603.9052	68531.0388
\$67.31	45768.679	68327.1876
\$63.65	44504.5902	67739.8023
\$55.66	44670.6903	65033.6029
\$32.01	42722.2057	63752.7927
\$18.38	35095.8114	53770.714

In table 4, the oil spot price is the dependent variable Y, the total quantity imported and the total quantity produced were the independent variables X1 & X2 respectively. Since there is more than one independent variable, a multiple regression was performed. The R2 value based on table 4 came out to be 75.57% which implied that that the spot price of oil can be predicted with an accuracy of 75.57%.

The below given regression equation [Equation 1] gave an approximate straight-line relation between the independent and the dependent variables.

Equation -1: Regression Equation

$$\text{Oil spot price (EUROPE) - Brent} = -169.2 + 0.000099 \text{ Total quantity imported} + 0.003387 \text{ Total quantity produced}$$

In Table 5, the coefficient of both the independent variables, 'Total quantity imported' & 'Total quantity produced' was positive, hence the spot price of oil was positively correlated to them, meaning an increase in either of two would result in an increase in oil price and vice versa. The coefficient of 'Total quantity produced' was greater than the coefficient of 'Total quantity imported' hence the price of oil depended more on the quantity produced.

Table -5: Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-169.2	37.9	-4.47	0.001	
Total quantity imported	0.000099	0.000258	0.38	0.707	1.16
Total quantity produced	0.003387	0.000616	5.50	0.000	1.16

From the model summary [Table 6] it was understood that the spot price of oil could be predicted with an accuracy of 75.57%, for points lying within the domain of data points given above [Table 4].

Table -6: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
7.7374	75.57%	71.50%	0.00%
7			

From Table 7 it is concluded that:

Null Hypothesis (H0) = There existed no association between the independent and dependent variables and the level of significance (LOS) was taken to be 5%.

The P-value for X2 that is total quantity produced was approximately zero (i.e. P < LOS), it was concluded that there was enough evidence to reject the null hypothesis. Which means that there was some association between X2 and Y.

On the other hand, P-value for total quantity imported (X1) was greater than LOS meaning there was enough evidence to accept the null hypothesis meaning there was no association between X1 & Y.

Table -7: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	2222.76	1111.38	18.56	0.000
Total quantity imported	1	8.85	8.85	0.15	0.707
Total quantity produced	1	1809.88	1809.88	30.23	0.000
Error	12	718.42	59.87		
Total	14	2941.18			

The table shown below [Table 8] gave the difference in actual and predicted value for some unusual observations.

Table -8: Fits and Diagnostics for unusual observations

	Oil spot price (EUROPE) - Brent	Fit	Residue	Std Residue		
5	64.22	65.82	-1.60	-1.22		X
14	32.01	50.92	-18.91	-2.57	R	
15	18.38	16.36	2.02	0.76		X

R Large residual
X Unusual X

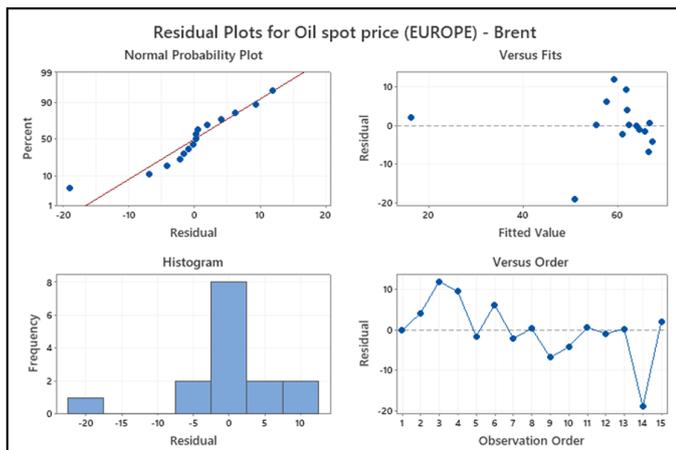


Chart -4: Residual plot for spot oil price

From the tables 5, 6, 7 & 8 and equation 1, it was concluded that a change in the total quantity produced could help tackle the problem.

5.4.1 Steps taken by the G20 and OPEC+ nations to solve the crisis

As the world is still adjusting to the obstacles set forth by the onset of this pandemic, oil industries are already making efforts to abate the situation and break ground as soon as possible. The April report released by IEA [12] suggests that two important measures have been taken to tackle the crisis:

- The IEA has urged all major consumers and producers of oil to work together to moderate the effects of the crisis through the G20 summit. On Friday, 10th of April a meeting was held by all Energy ministers of the G20 to decide on the production cuts and those present have offered to provide their support to the oil producers during these trying times.
- The OPEC+ group has agreed to cut production by 9.7 million barrels per day (mb/day) initially effective May 1.

Though the steps taken by the G20 countries won't immediately improve the situation, it will reduce supply thus solving problems of storage as the oil already in stock will be pushed into the system. IEA has forecasted a drop in demand of oil for the months following April [12] as follows:

- A drop in oil demand in April of as much as 29 million barrels per day year-on-year.
- May is also expected to see a plunge in oil demand close to 26 million barrels per day year-on-year.
- From June onwards we'll see an improvement in demand, although it will still be 15 million barrels per day short of last year.

The near-term demand losses cannot be subsided no matter how much we reduce the daily oil supply, but it will surely have an effect in the long-term demand.

5.5 Control

The primary purpose of this phase is to ensure the smooth implementation of the improvements suggested in the earlier phase and design a control plan so as to either avoid such a crisis in the future or to be well aware of it in advance.

5.5.1 Effect of the initiatives taken by the G20 and OPEC+ countries during April summit

- The OPEC+ alliance agreed to cut production effective from May, by 10.7 million barrels per day instead of the earlier agreed figure of 9.7 million barrels per day as oil production in April was high.
- India, Korea, China, and United States all agreed to provide some temporary alternative to store the excess oil being produced or are making plans to take advantage of the situation and buy crude at a cheaper price.
- Producers of oil other than the OPEC+ countries have also agreed to cut back on oil production to help the industry get out of this turmoil. IEA estimates Canada and U.S to reduce production by as much as 3.5 million barrels per day, in coming the months to tackle the low prices.

The cuts made in oil production will ensure that the second half of 2020 will see a deficit of oil supply & possibly an increase in demand a thus help in normalizing the market [12].

5.5.2 Graphical Analysis to compare the price of Brent Crude oil month-to-month

For the months of January to April the oil prices showed a decreasing trend:

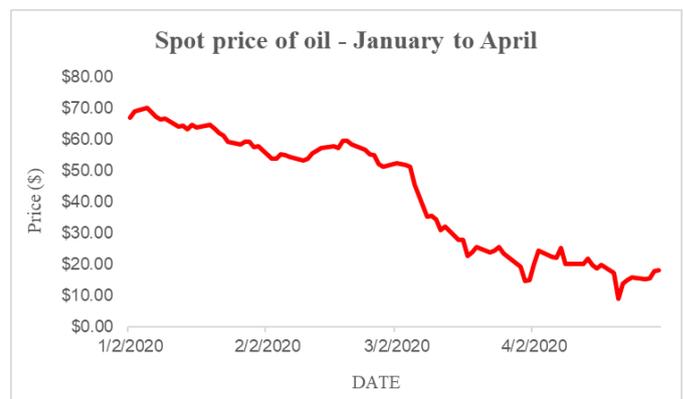


Chart -5: Graph for spot price of oil – January to April

For the month of May to June the price of oil showed an uptick as shown:

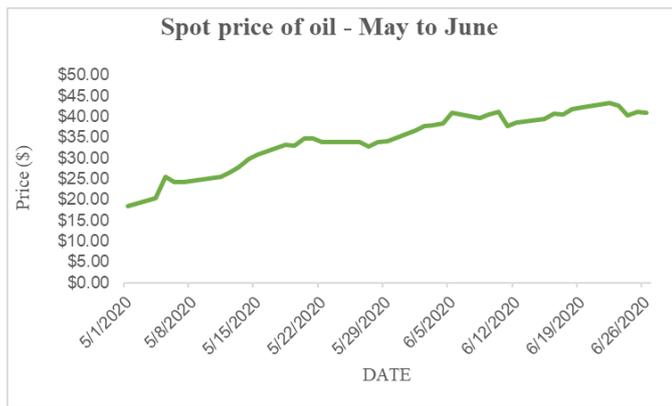


Chart -6: Graph for spot price of oil – May to June

The graph clearly indicates that the decisions taken during the OPEC+ & G20 summit have been effective and oil prices slowly returning back to normal.

To make sure that such a crisis is averted in the future or at least known about before-hand a flowchart [Figure 4] is developed to track the supply & demand cycle. Since political factors cannot be quantified, they have not been included in the flowchart.

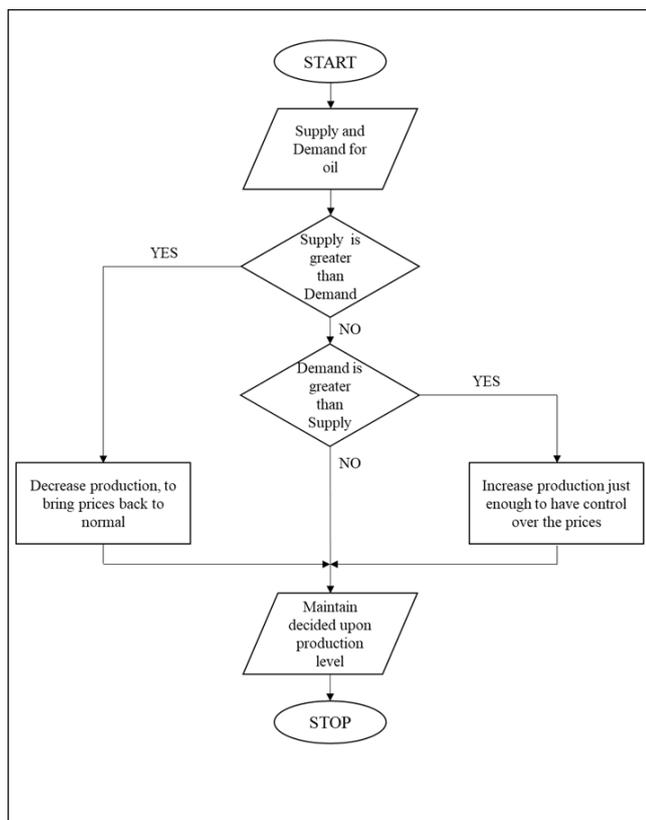


Fig -4: Flowchart

On the basis of root cause analysis, it was concluded that one of the major reasons for this crisis was the imbalance in the supply and demand cycle, specifically the supply was much greater than the demand. Along with it there were certain

political factors as well but since they are highly unpredictable in nature, it is difficult to develop a contingency plan for them. To maintain the supply and demand cycle, a flowchart is generated.

In case of an imbalance in the supply-demand dynamic

- If supply is greater than the demand: Decrease the oil production levels in order to bring the prices back to normal.
- Else if demand exceeds the supply: increase production whilst keeping prices in check.

If the supply-demand dynamic is balanced:

- Maintain decided upon production levels.

6. CONCLUSION

The paper represents how the six-sigma methodology DMAIC can be applied to the oil crisis of 2020 by making use of various statistical and six-sigma tools such as Regression analysis, Cause and effect analysis, Flowcharts and Graphical analysis. To implement the DMAIC approach, the problem at hand and its root causes were identified using Fishbone diagram. The oil consumption around the globe post the coronavirus pandemic was measured using graphical analysis and its impacts were noted. Measures taken by the G20 and OPEC+ countries to improve the situation were explored from the literature and a control plan was suggested to determine in advance the occurrence of such a crisis.

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