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The petroleum demand of Bangladesh using crude oil refining process: the most economically efficient manner

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ABSTRACT
In Bangladesh, fuel demand is depended on refined oil import process. Instead, importing crude oil and refining with our own process capacity reduces the cost at a greater extent. A crude refinery plant with according work capacity can save millions of dollars of money that is currently being spent from foreign exchange reserves. To meet this breach between demand and supply, a particular analysis should be developed with all the crude available to import for Bangladesh. Tracing the demand level of particular user grade fuel of previous years, upcoming yearly fuel demand can be estimated. Another big problem in this field is the supply chain management of the crude oil itself. Depending on global, political, environmental, economic and other aspects can vary the industrial quality and supply quantity in almost no matter of time. So, in this very uncertain but important field a reliable process of analysis is necessary. To develop such analysis country demand, management and storing capacity, refined oil import value, mass oil import transportation should be considered. Crude refine ability, processing, availability, relevant costing and profitability are the fundamentals for this analysis. Thus with any situation of demand and supply, an organized process of analysis is ready to bring back the supply demand synergy. There is always a substantial imbalance between supply and demand of diesel. That is roughly 3.5 million tons per year, which will eventually expand in future. For sudden change of supply or demand, the analysis still works to maintain a perfect match.

Keywords: Crude oil, Yield, Barrel, Refinery, Refined oil.

1. Introduction

Crude oil is a hydrocarbon mixture that exists in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separation facilities. Crude oil will be an essential raw resource for years to come, mostly for the chemical sector, transportation, power, agricultural and industrial sectors because it is too valuable to be used for heating or as fuel. Crude oil is ubiquitous and necessary in today's life. Petroleum is regarded as an economy's lifeblood. It has a significant direct and indirect impact on all economic sectors. And Crude oil is the part of petroleum found in nature.

To use crude oil, it must first be refined. Petroleum oil refinery is a well industrial sector worldwide. There are approximately 700 refineries in operation worldwide [1]. Eastern Refinery Limited (ERL) is the only country-owned oil refinery in Bangladesh which commercially operation back in 1968. ERL's current capacity is around 33,000 barrels per day [2]. In Bangladesh, petroleum products are used in a wide variety of ways. The two main types of fuel used in transportation are gasoline and diesel. LPG and kerosene are commonly used as cooking fuels, whereas furnace oil is mostly used for the production of power. Diesel is also widely employed in the power and irrigation industries in agriculture.

Although there are gas mines in Bangladesh, crude oil is not available. That is why Bangladesh are always reliant on other countries which is available to export crude oil. However, the demand for furnace oil is met through the amount of crude refined in Bangladesh. Again, it is no longer viable to fulfill the domestic gas demand with the country's extracted gas. As a result, Bangladesh must now import gas. The Bangladesh government faced a major challenge as a result of the instability of petroleum and price imbalances during the Corona epidemic.

73.77% of total energy coming from Fossil Fuel Energy Consumption in Bangladesh [3]. Fuel consumption has always been dependent on the refined oil import process from the very beginning in Bangladesh. According to Bangladesh Petroleum Corporation (BPC), Bangladesh spent $4.85 billion for imported oil (2018-19 financial year). Which is approximately 8.82% of total budget [4]. Currently, BPC imports nearly 80% of the petroleum demand from various countries to support the energy needs of the aforementioned sectors [5].

Because of political, cultural, or adequacy difficulties, it is not always possible to import enough refined oil. That is why there is always a deficit in Bangladesh. To address the breach between demand and availability, a specific analogy with all of the oil available for import into Bangladesh should be constructed. Bangladesh typically imports LPG, Naphtha, Gasoline, Jet A-1, kerosene, Diesel, furnace oil, lube oil, bitumen, and other petroleum products [6]. This analogy describes how Bangladesh's domestic oil deficit can be met solely through crude oil imports and refining, as well as how much money can be saved per year.

This paper predicts which crude oil will be obtained at the lowest cost and most efficiently, as well as how much will be utilized to satisfy Bangladesh's entire demand and what positive influence it will have on the economy. Total Profit Analysis was also analyzing in this paper and the task was completed in the most efficient

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manner. And all of the calculations have taken into account all of the restrictions.

2. Methodology

A refinery has the capacity to process a variety of crude oils. Crude oil must be converted into items that can be used in the marketplace because it has no value to consumers in its natural state. The chemical assessment of crude oil feedstocks by petroleum testing facilities is essentially what a crude oil assay entail. There are significant changes in crude oil quality and every form of crude oil is unique. They differ in terms of their chemical make-up, physical characteristics (density, viscosity, etc.), and sorts of contaminants like metals, sulfur, and other elements.

Table 1 Crude oil properties [7].

Name	Iran light	Arabian light	Sokol (Sakhalin I)	Murban
Country	Iran	Saudi Arab	Russia	UAE
°API	33.80	33.40	34.80	40.50
Sulfur (wt. %)	00.86	00.86	00.85	00.82
Price (USD per barrel)	116.99	115.09	105.33	119.59
Specific gravity	0.856	0.858	0.851	0.823
Yield (%)				
Petrol	17.10	14.60	10.30	22.20
Diesel	25.50	27.20	47.40	30.30
Kerosene	8.00	8.30	11.30	12.50
Gas	1.50	1.90	3.20	1.00
Furnace oil	47.90	48.00	27.70	34.00

2.1 Demand Analysis

Oil is the most valuable commodity and is utilized in a wide range of products, including fuel, polymers, and asphalt. Governments, businesses, investors, and traders closely monitor fluctuations in oil prices because the oil sector is a major driver of the global economy. The world economy can experience shocks as a result of volatile oil prices. Oil prices are also influenced by variations in demand and supply. Oil is not, however, a luxury good with limited utility that most people can survive without. Due to its abundance and high demand, oil's price is mostly determined by market forces.

Table 2 Estimated amount of total demand oil in Bangladesh [8].

Fiscal Year	Demand (MT)		
	Diesel $\times 10^5$	Petrol $\times 10^4$	Kerosene $\times 10^4$
2020-21	48.0	35.5	16.0
2021-22	50.0	36.0	16.0
2022-23	52.0	36.5	16.0
2023-24	54.0	37.0	16.0
2024-25	56.0	37.5	16.0
2025-26	58.0	40.5	16.0
2026-27	60.0	43.5	16.0
2027-28	62.0	44.0	16.0
2028-29	65.1	44.0	16.0
2029-30	75.5	51.6	15.7

2.2 Supply Analysis

Bangladesh has some in-country government and non-government oil refinery that supplies refined oils in the market. Although this is a small amount comparing to the demand of refined oil supply. Supply of in-country refined oil does not have any significant growth rate. Negligence of responsible authority and absence of proper planning of big scale refining facilities are the reason behind this scenario. The average amount of refined oil developed in Bangladesh by refining crude oil in several years are as follows.

Table 3 Amount of total in-country supplies in Bangladesh [9].

Fiscal Year	Supply (MT)		
	Diesel $\times 10^4$	Petrol $\times 10^4$	Kerosene $\times 10^3$
2014-15	09.69	09.69	09.69
2015-16	09.01	12.37	19.74
2016-17	12.98	19.19	16.05
2017-18	11.78	18.88	14.79
2018-19	09.65	21.08	20.94
2019-20	07.70	21.26	21.31
Average	10.13	17.08	17.08

2.3 Amount of Lacking oil

This lacking amount of refined oil is generated by a simple subtraction of average in country refined oil supply from the demand. Bangladesh has a huge breach between the demand and in-country supply capabilities. This causes the country a huge amount of money exporting the lacking amount of refined oil. Diesel has the highest demand and lowest supply causing a very large quantity of lacking. The 95% of total amount of diesel, petrol and kerosene demand is lacking.

Table 4 Amount of lacking oil in Bangladesh.

Fiscal Year	Lacking (MT)		
	Diesel $\times 10^6$	Petrol $\times 10^6$	Kerosene $\times 10^6$
2020-21	4.70	0.18	0.14
2021-22	4.90	0.19	0.14
2022-23	5.10	0.19	0.14
2023-24	5.30	0.20	0.14
2024-25	5.50	0.20	0.14
2025-26	5.70	0.23	0.14
2026-27	5.90	0.26	0.14
2027-28	6.10	0.27	0.14
2028-29	6.41	0.27	0.14
2029-30	7.45	0.35	0.14

This is a graphical representation of table 4 data.

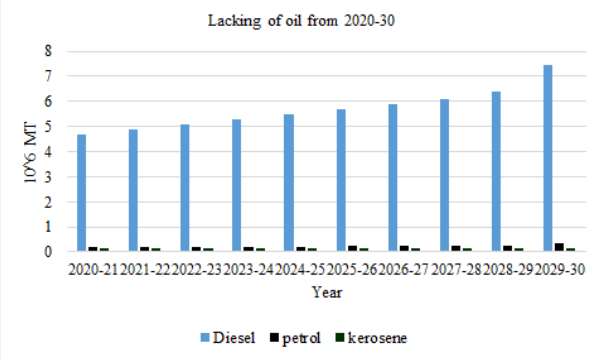

Fig.1 Lacking of refined oil from 2020-30 in Bangladesh.

2.4 Cost analysis of refined oil import

Bangladesh imports refined oil about 11% of its total import structure. This is the highest for a singular sector of import. These costs a lot of foreign money that could be saved by importing crude oil and refining the crude in the country facilities.

Table 5 Import cost of refined oil [10,11].

Oil	Per barrel refined oil import cost (USD/BL)	Per barrel refined oil import cost (Thousand BDT/BL)
Petrol	119.425	11.1
Diesel	153.080	14.3
Kerosene	148.120	13.8

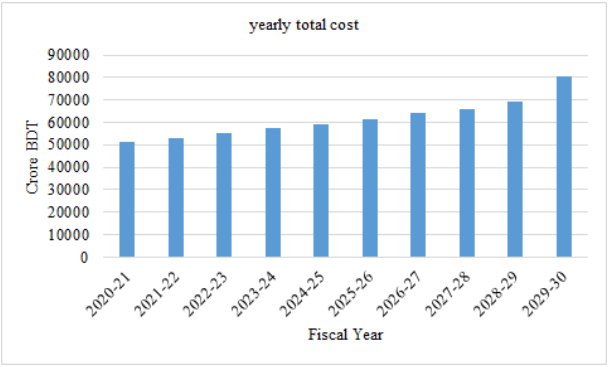

Fig.2 The cost to fulfill the lacking by exporting refined oil.

2.5 Conditional analysis

For 2024-25 financial year, lets identify some real time conditions as follows:

1. The summation of yield multiplication of diesel, petrol and kerosene should be equal to the lacking of the according year.

Other conditional aspects can also be involved in the conditional analysis. As an example, in this analysis for 2024-25 financial year,

2. Minimum export quantity of crudes has been set 10,000 Metric Ton. Per barrel remining cost has been estimated 30 USD.

3. By using solver in Microsoft Excel with these conditions as mathematical equations, an appropriate measurement appears that covers all the conditionals provided on the basis of Linear programming.

The mathematical equations that represents the above conditions are provided below,

The amount of petrol =

$$0.171 \times a + 0.146 \times b + 0.103 \times c + 0.222 \times d;$$

The amount of diesel =

$$0.255 \times a + 0.272 \times b + 0.474 \times c + 0.303 \times d;$$

The amount of kerosene =

$$0.080 \times a + 0.083 \times b + 0.113 \times c + 0.125 \times d;$$

And $(a,b,c,d) \geq 10{,}000$;

Here, a represents amount of Iran Light
b represents amount of Arabian Light
c represents amount of Sokol
d represents amount of Murban.

Table 6 The most efficient quantity of crudes to import and refine at provided conditions to touch the demand.

Crude Oil	Export quantity (kMT)	Cost of exporting + cost of refining (Crore BDT)
Iran light	13.11	17.94
Arabian light	10.00	13.51
Sokol	11,600.53	14621.74
Murban	13.10	18.26
Total	11,636.74	14,671.46

As the diesel has highest individual demand, there must be some extra refined oils that is eligible to export in the international market. This will help to earn extra foreign exchange, reduce the processing cost of the crude and generate more profit margin.

Table 7 Amount of exportable oil and price [12].

Refined Oil	Exportable Quantity (kMT)	Price of Exporting (Crore BDT)
Petrol	997.26	9825.96
Diesel	0.00	0.00
Kerosene	1,171.46	1,2705.23
Gas	371.73	591.86
Furnace oil	3,228.88	2,3577.37
Total	5,769.33	46,700.42

3. Result

A stainless-steel edible crude oil refinery plant worth 50-500 ton crude refining capacity per day costs 58.71 lakh in international market (Infocom Network Private Limited, 1999-2022).

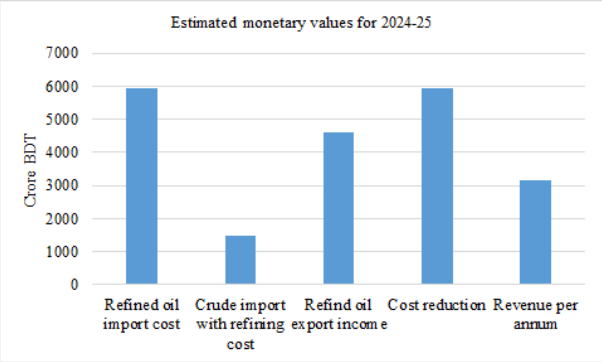

Fig.3 Organized monetary data values for 2024-25 financial year.

Thus, to generate a 31881.48 MT daily refining capacity, 64 devices would be enough, costs about 40 crore BDT. Other external costs such as land, labor, transport has not been considered here. Best thing about this analysis is that, it gives instantaneous solution according to the situation along with a further aspect of assumption.

4. Discussion

It is quite tough to pick a suitable combination of crude oil for any country. There are always hurdles to importing and exporting crude oil, such as shifting legislation, fiscal regimes, strategic and political concerns, developing lifestyles, natural calamities, and of course, human mistake. API gravity is a commonly used density index for crude oil or refined products that is also consider to select crude oil. Sulfur compounds are undesirable in the refining process due to their proclivity for catalyst deactivation during crude oil processing. They are also poisonous and can cause corrosion of pumping equipment and pipes. The Sulfur concentration in crude oils varies from less than 0.05% to more than 10% (weight percent) but commonly lies in the range 1–4 %. Crude oil with less than 1% sulfur is referred to as low sulfur or sweet. The sulfur level of each of our selected crude oils is below 1 percent and the collectable API range is 33-40. Though the property specific numbers always considerably vary depending on the mine, mining process, transport, containing process and other natural factors.

However, there are also a number of barriers to conquer when it comes to choosing crude in this instance by a whole effective approach. Diesel demand is so high in Bangladesh. That it is even higher than the combined demand for petrol and kerosene. In Bangladesh, overall demand for diesel exceeds 70%, which is 12 times that of petrol and 10 times that of furnace oil. However, in most crude oil cases, the ratio of petrol, diesel, furnace oil is pretty near. In some case the yield of diesel is doubled. As a result, satisfying demand for diesel, kerosene, gasoline, furnace oil, and gas became challenging. Sokol (Sakhalin I) have the largest diesel output, which is around 47.4 percent. As a result, only via the import of Sokol (Sakhalin I) can the country's internal demand be met most effectively. Even after meeting demand for gasoline, gas, and furnace oil, kerosene will be available. But Russia cannot export that many Sokol (Sakhalin I) each year. Furthermore, the instability of the oil market as a result of the war situation is a major challenge.

So, in order to alleviate the pressure on the Sokol (Sakhalin I), Arab Light, Murban, Iran Light is also calculated through Linear Programming on excel software considering with a minimum of 10,000 MT. Even so, a large quantity of Sokol (Sakhalin I) must be imported from Russia what is 11600536 MT. Besides, 10000 MT Arabian Light, 13107.2 MT Iran Light and 13108.2 MT Murban have to be bought to meet the diesel demand of the country.

Crude oil prices are far more volatile, sometimes climbing and dropping multiple times each minute. So, the average price has been calculated over a specified time period. The price of refined oil differs from that of crude. Here, too, an average cost is derived. Different kinds of crude oil cannot be refined at the same time. This computation is also conducted here, but for each crude oil independently. Again, another main issue is that statistics on crude oil is extremely scarce. Collecting data from a credible source is sometimes difficult.

Even yet, after fulfilling demand, a large amount of petrol, diesel, furnace oil and gas is available to export as refined oil. Alternatively, available gas could be used to supplement the country's ongoing gas shortage. It is feasible make revenue 32028.96 crore BDT in a year by exporting surplus oil to this need.

5. Conclusions and Future recommendations

Bangladesh has only one oil refinery, Eastern Refinery Limited (ERL), with a capacity of roughly 33,000 barrels per day. As a result, Bangladesh is not prepared to process 11,636,751 MT of oil in various ways each year. To apply it, at first develop an ideal

well refining industry. But the demand for well refineries will continue to rise year after year.
The year 2020 was the worst for the oil market. Because to the closure of cars, trucks, airlines, and industries, the demand for teak dropped dramatically. The endogenous variable is US oil prices, while the measure of Corona prevalence is COVID-19 daily fatalities cases. Previous research on the implications of the COVID-19 fatalities pandemic on oil prices has been sparse, and this analysis adds to the rapidly developing literature.
OPEC members control 40% of the world's oil supply. Again, crude oil data is extremely scarce and costly. Obtaining uncommon and expensive crude oil data is problematic in order to analyze the situation and develop a suitable solution. Crude oil is one of the economy's most vulnerable industries. The price of petroleum products has a large impact on macroeconomic indices. This comparison will evolve in response to time and demand. When a result, an algorithm may be developed to simply modify the need for oil as demand changes later, which is the most lucrative for Bangladesh.

7. Acknowledgement

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NOMENCLATURE

LPG – Liquefied Petroleum Gas
MT – Metric Ton
USD – United States Dollar
BDT – Bangladesh Taka
BL – Barrel