SUPPLY CHAIN MANAGEMENT OF DOWNSTREAM RETAIL OIL AND GAS PRODUCTS – IMPERATIVES FOR NEXT GENERATION E-GAS STATION

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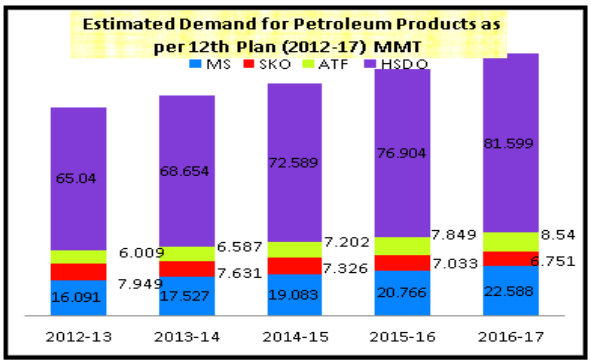
ABSTRCT : *Supply of energy through fossil fuels is already coming under strain impacting economies such as India. Energy governance is already being discussed in all forums and as a first steps restrictive policies have been formulated for LPG Cylinders where in specified numbers of cylinders are being provided at a subsidized rates. The same approach will eventually be applied for petroleum fuels such as Petrol, Diesel, ATF etc. The paradigms are likely to change with likelihood of quota based distribution or measurement of energy consumed at vehicle level. Modern technologies makes it possible for Oil companies to come out with completely integrated architecture to bring in intelligence on the overall supply chain of fuel oil all the way up to a vehicle where an engine level efficiencies could be tracked. This paper attempts to identify a framework which uses RFID technology for identifying and tracking vehicles, GIS for intelligence on the productive throughout or useful work computation and Big Data analytics for making sense of this enormous data. The paper also attempts to simplify supply side of fuels at retails stations through automation*

Key words: Downstream, Big Data, GIS, Transportation, e-Gas Station, Retail

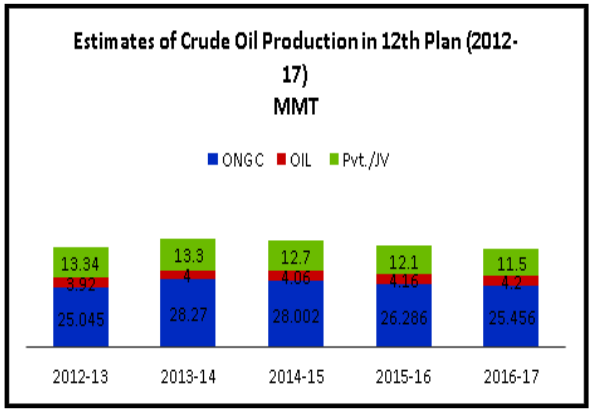
1 INTRODUCTION:

We are all in a regime where LPG Gas distribution is rationed with quota based supplies at subsidised rates, where government agencies refund the discounted amount for the fixed numbers LPG cylinders per annum to the consumers. Any additional LPG Cylinder over and above the yearly quota costs considerably more. The depletion of hydro-carbon based fossil fuels and increased cost of oil exploration and crude prices have already put significant strain on the overall economy of India. Almost 80% of India's oil demands are met by imports which results in shrinking India's Foreign Exchange reserves which in effect impacts the exchange rate of Indian Rupee viz-a-viz US Dollar. We have seen that the cost of petrol, diesel and other products are determined based on market conditions which have have gone up considerably over last few years.

Going by the same logic, it is inevitable that we will have a situation where distribution of petrol and diesel will be controlled by the government and some kind of 'rationing" will be enforced as is the case for LPG Cylinders. The consumption of energy in terms of usage of fossil fuel is increasing day by day. Figure 1 below depicts the estimated demand for petroleum products as presented in the 12th plan. The figure depicts demand for MS (Petrol), SKO (Kerosene), ATF (Air Turbine Fuel) and HSDO (High Speed Diesel Oil).



(Figure 1: Demand for Petroleum Products in India as per 12th Plan)



(**Figure 2: Crude Oil Production in India as per 12th Plan)**

During the same period, the crude production in India by ONGC, Oil India Limited and other private players is expected to be as illustrated in Figure 2:

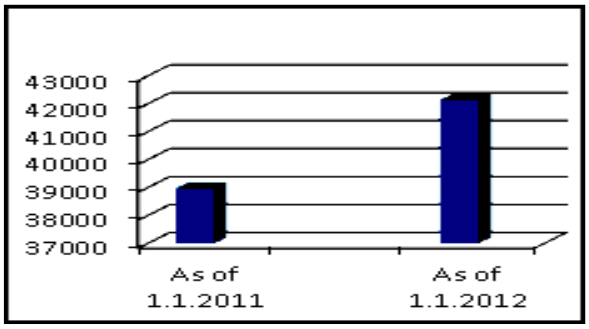
As we can see from the above graphs, the crude production in India is likely to be relatively flat while the imports are likely to go up significantly by almost 22.3 %. This is likely to impact India's foreign exchange reserves, exchange rate, inflation and overall economy at large. Obviously such drastic impact is not sustainable and is likely to invite controls which are hereto not being administered. Some of the likely possibilities are:

- Need to enforce a fixed quantity of fuel per vehicle
- Fixed quantity of fuel per vehicle at regulated prices and balance at an increased prices, similar to the mechanism adapted for LPG Gas Cylinders
- Efficiency linked allocation of fuel quota, i.e. less efficient vehicles to pay more for the price of petrol to discourage use of inefficient vehicles
- Minimum occupancy norms for the vehicles plying on the road
- Restrictive mobility (For eg. odd/even numbered vehicles not allowed on particular days of the week)

Regardless of the mode or the approach adapted to monitor and govern distribution of this vital energy, the entire supply chain and distribution channel needs to be transformed considerably.

The Fuel distribution of Petrol, Diesel is primarily managed through the network of retail gas stations. These gas stations are either owned by oil companies or by private owners.

Figure 3 gives the growth of numbers of gas stations from 2011 to 2012 in India.



(Figure 3: Total no of retail outlets in India)

The retail gas stations are operated based on multiple modes as below:

COCO: Company Owned Company Operated
CODO: Company Owned Dealer Operated
DODO: Dealer Owned Dealer Operated

Most of the westernized and developed economies have large numbers of retail stations operating under COCO mode. However over 80% of retail gas stations in India are functioning under DODO mode.

This paper is an attempt to develop a futuristic e-Gas Station which adapts modern contemporary techniques to provide detailed insight on the way the fuel will be dispensed and also the way it will be consumed for

generating productive work. The framework will include adapting processes for next generation Gas Station which will comprise of:

- Supply side process improvement using modern piezoelectric or transducer based Tank Level Gauges
- Adapting "Vendor Managed Inventory" concept for storing fuel products, meaning the visibility of availability of fuel in the station will be with the company thus eliminating stock outs
- Use of RFID to capture vehicle information and distance travelled (Kms), , as well as amount of fuel dispensed
- Tracking of vehicle movement including distance travelled and productive work derived based on fuel energy consumed, which will give an ability to eliminate inefficiencies and waste
- Exploring option of offerings that include value added service from Oil and Gas companies to consumers based on modern GIS based tools and techniques using analytics such as Big Data applications

The above is possible by internet enabling the Gas Stations and integrating the data across all stations in the country. This is no different from having a bank account which can be accessed from anywhere. The benefits are immense as stated above and can transform the petroleum industries future considerably. The next section details the overall framework being proposed.

2 FRAMEWORK OF NEXT GENERATION E-GAS STATION:

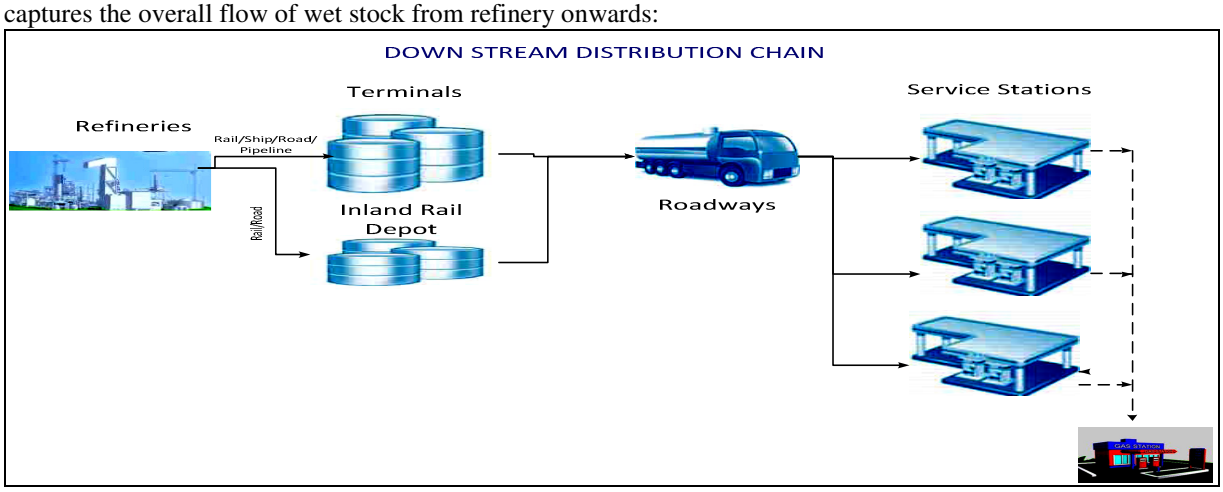
The framework is comprises of following elements:

- Fuel Stock Management using automated Tank Level Gauge based replenishment process
- RFID based vehicle information capture system as well as GIS for vehicle tracking
- Big Data application for generating intelligence and energy balance

The concept being used is to ensure that the energy received at the e-Gas Station is balanced by the fuel dispensed to the vehicles that have received the fuel and analysing the same with actual distance travelled in order to compute the overall efficiency of Fuel Value Chain. This whole model can be integrated across all oil companies.

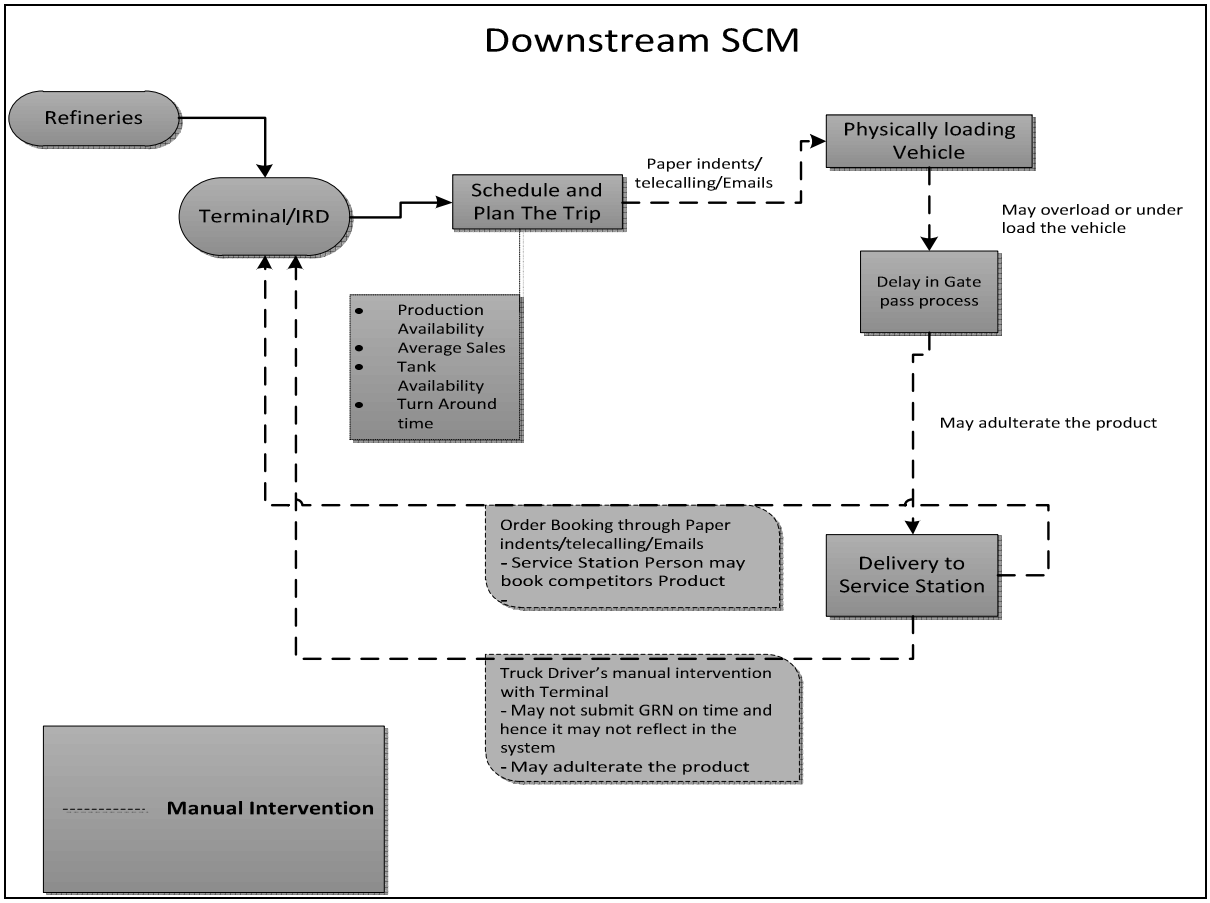
2.1 AUTOMATED WET STOCK MANAGEMENT

The basic idea of automated Wet Stock Management is to have a Tank Level Gauge integration with the petroleum companies and Terminals and Depot's from where the wet stock is being replenished. Figure 4 captures the overall flow of wet stock from refinery onwards:



(Figure 4: Wet Stock movement from refinery to service stations)

The business process currently followed along with areas of inefficiencies and those where manual inputs are needed is described in the below figure 5:

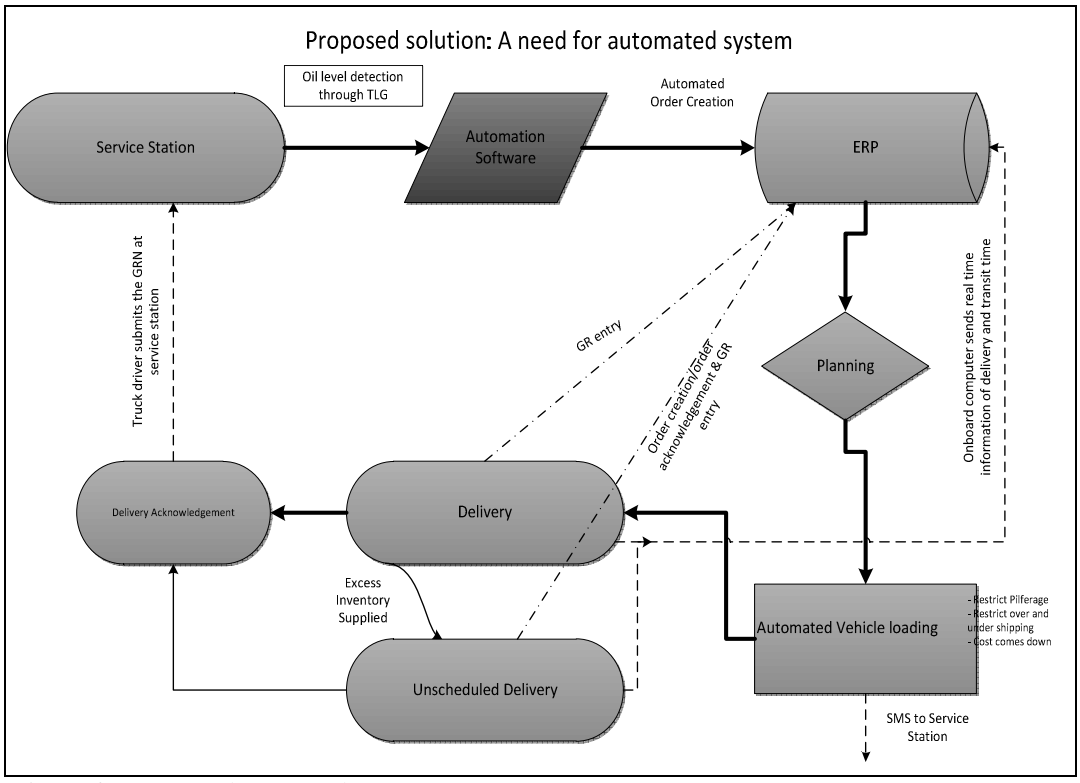


(Figure 5: Process of triggering ordering of Wet Stock from refineries to replenish service station stocks)

The overall process envisages dealer to order the stocks manually based on his requirements. The entire process of Wet Stock supply chain has main deficiencies as below:

- Poor planning and forecasting. Dealer misses the process of ordering resulting in stock out at retail station
- During holidays, customers demand goes up which cannot be responded to using this conventional process
- Route optimization of tankers by the petroleum companies is not optimum
- SMS messages on tank level depletion, replenishment order, shipment confirmation and receipt
- Lost sales or possibility of replenishing from other competing company

This entire supply chain can be automated using Tank Level Gauge operated replenishment system. The modified process looks as per Figure 6 below:



(Figure 6: Automated Wet Stock Management)

There are multiple benefits of this system:

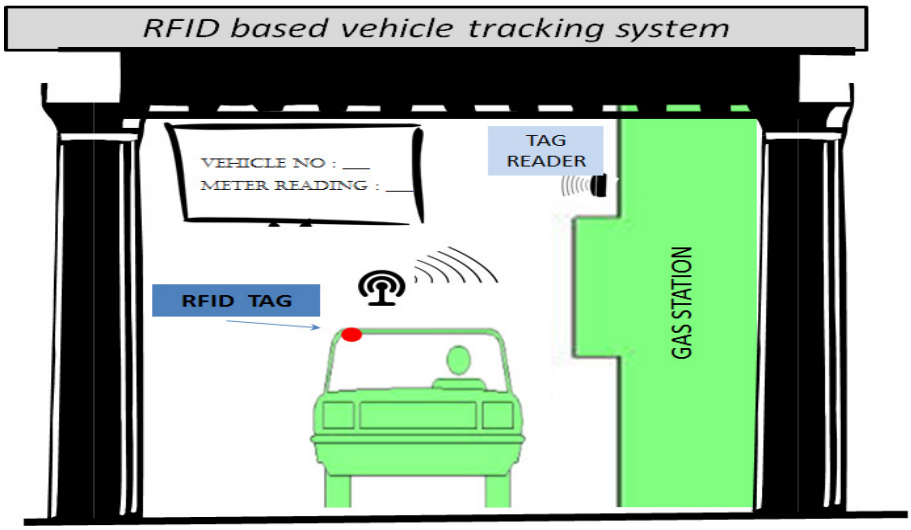
- No manual intervention
- Automated reorder point
- Reconciliation of stocks with transactions possible, adulteration virtually eliminated
- Better refuelling forecast and plan
- Optimized route plan
- Better inventory planning
- Better refinery planning

2.2 AUTOMATED VEHICLE TRACKING SYSTEM:

This is a simple RFID Tag based system where each vehicle entering the gas station will get scanned by RFID reader which will give following information:

- Vehicle Number
- A GIS based system to capture kilometres travelled using GIS system
- The system can also generate the data on speed at which the vehicle was driven
- Fuel consumed by period
- Buying behaviour, amount of petrol consumed
- Forecasted requirements

The system would look as per figure 7 below:

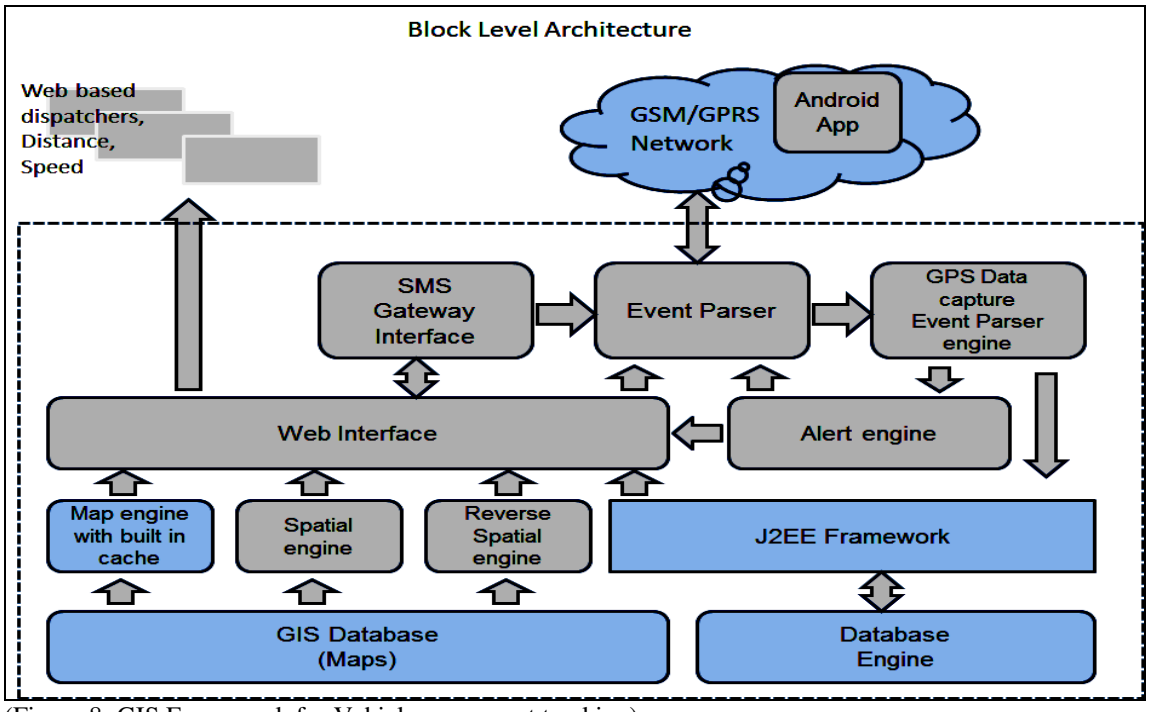


(Fig 7– RFID Tag based Vehicle Tracking System)

Using a GIS and BigData system, it would be easy for the Petroleum companies to obtain the following:

- Accurately control the fuel supplies as per the entitlement, should there be such guidelines in future
- Availability of information about the distance covered by the vehicle and relative efficiency (this facility will have some implication on privacy and security laws which would need to be assessed)
- Ensure energy balance including vapour losses and wastage
- Identify pilferage as all the supplies and dispensing transactions would balance out

The GIS Framework will comprise of the hardware and software elements as per the figure 8 below:



(Figure 8: GIS Framework for Vehicle movement tracking)

2.3 ENSURING ENERGY BALANCE USING BIG DATA SYSTEM:

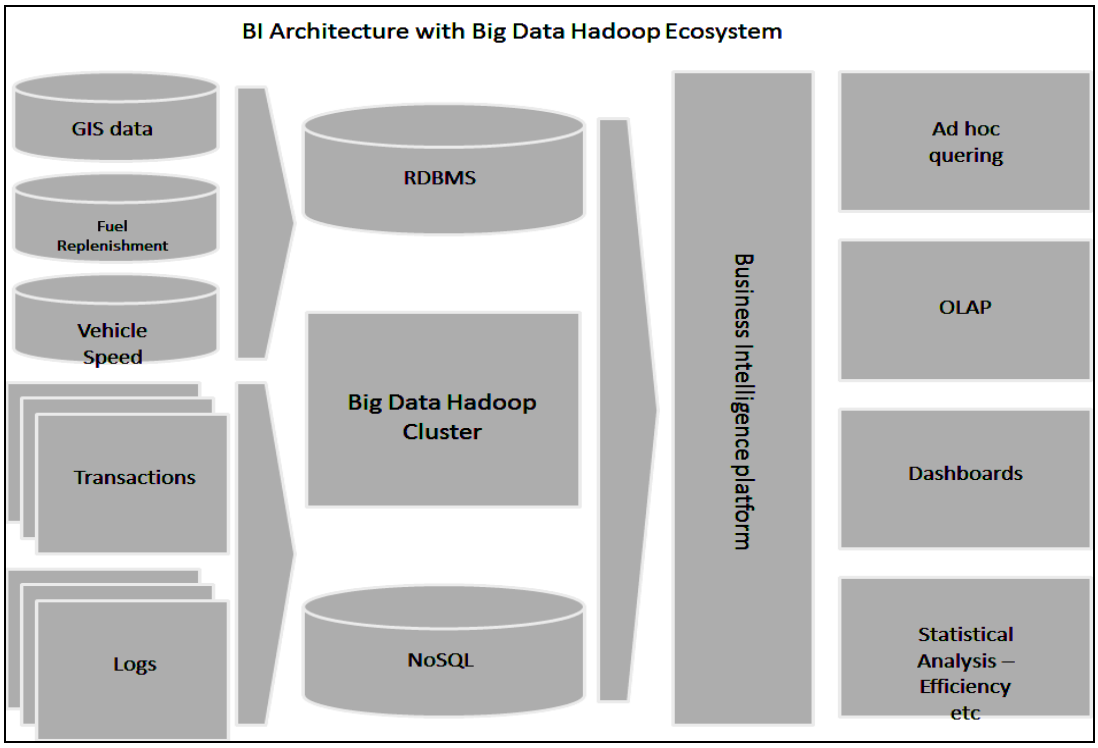
The most important outcome of the automation using TLG's on supply side and then dispenser operations using RFID tags and GIS is to feed such data in to a Big Data application. This will help in administering state policies such as fuel quota, balancing of supplies and ensuring total visibility of supply chain all the way upto the consumption. Following information will be captured into Big Data system:

- Vehicle information
- Fuel received over a period
- GIS data on distance travelled and speed

Big Data applications are supposed to manage large volumes, velocities and variety of data and can give the outputs at a Retail Operations level such as:

- Fuel received
- Fuel dispensed
- Loss of fuel in terms of spillage, vapour losses
- Pilferage, due to energy imbalance, by retail station
- Vehicles serviced by period (daily, weekly, monthly as needed)
- Analysis such as productive work (output) by consumption of fuel
- Efficiency of engine, losses and outliers (engines consuming more or less than average band)

It is important to know that since energy is so scarce that many of the above services could actually result in attracting customers as there are significant benefits derived from the overall system,=. The overall Big Data architecture would be as below:



(Figure 9: Big Data Hadoop System for Fuel Energy Balance)

3 CONCLUSION:

Fossil Fuel as a resource in not infinite and is depleting rapidly. China and India, being developed nations would have enormous energy needs. The energy and fuel governance would therefore need a completely different approach bringing in new paradigms such as quota per vehicle apart from imposing centralized governance on consumption and resultant output. The framework develop will help manage the fuel consumption per vehicle by integrating all the retail gas stations of the country regardless of who the suppliers of wet stock are. We have already seen imposition of regulations on use of LPG. The same logic will get extended to Fuels such as MS, ATF and HSDO etc. The framework proposed uses RFID tag for quick identification of vehicles, uses completely new paradigm of using Tank Level Gauge using mobility applications, based on which replenishment model for wet stock supplies would be functional and GIS based service to track effective work derived per vehicle by measuring distance. All this is now possible due to Big Data applications which handle massive data generation having very high volume, velocity and variety. Considerable benefits would be derived which would primarily result in optimization of fuel supply chain, and also by tracking efficiencies at vehicle level.

4 NEXT STEPS:

The framework proposed is a high level architecture which would need to be developed further to exactly explain the concepts and measure benefits. Also a critical view needs to be taken of issues pertaining to security, privacy and payload related aspects. Further research would be made in order to derive benefits of such a framework and quantification of the same. This along with detailing of the framework and development of reference architecture will be taken up as a next stage of research.

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