OPCO
2B OPERATING COMPANY

# Descriptive, Diagnostic and Predictive Analytics to Solve Various Production and Flow Assurance Problems in Block 2B in Sudan

**Presented by**

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# Outlines

- **Description of Data Analytics Workflow in 2B Operating Company.**
- **Challenges & Business Drivers in Production Department.**
- **Data Analytics Applications Developed by 2B Operating Company.**
- **Conclusion and Ways forward.**

# Description of Data Analytics Workflow in 2B Operating Company

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- **Developing a robust set of data analytics workflow following standard framework.**

- **Main Three Enablers are:**

  1- Effective team work and skills combination.

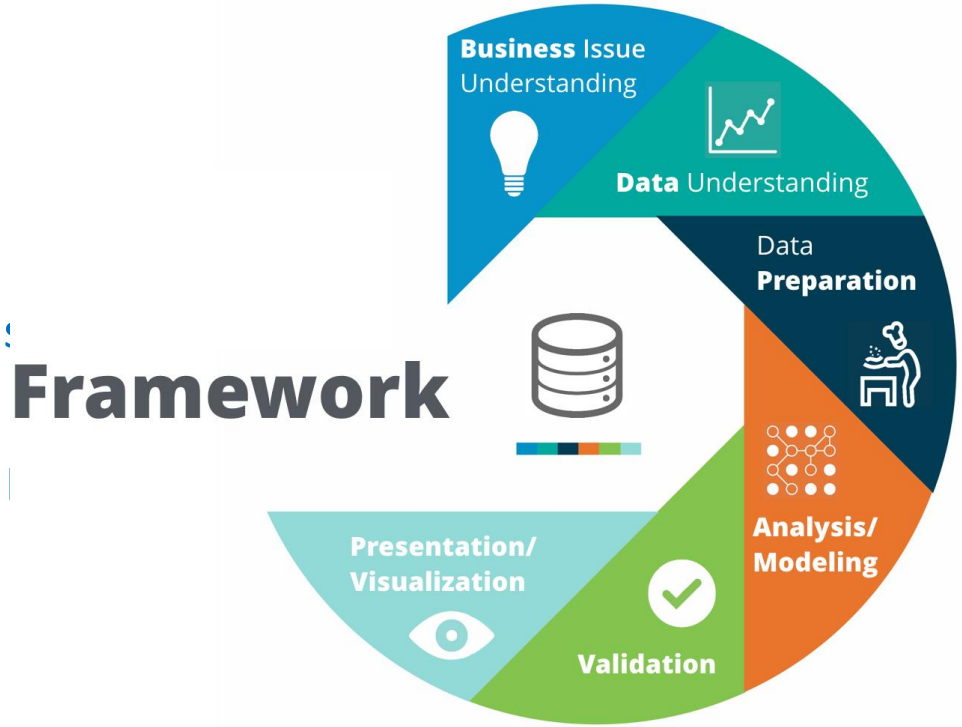
  Different engineering disciplines, software engineering, data s

  2- Integration of disparate systems.

  PIPESIM Open Link, AVOCET, shared folders, Outlook folders,

  3- Optimum utilization of available resources.

  Python libraries and APIs, SME, Rich Historical Data




- **Our journey from Digitization, Digitalization towards digital transformation.**

# Challenges & Business Drivers

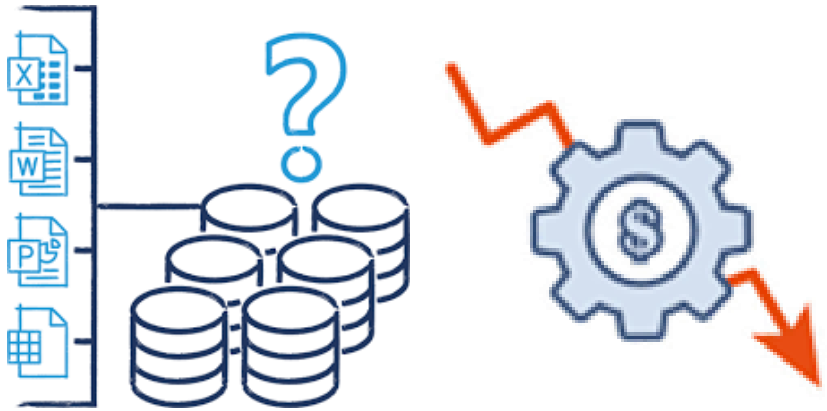
## Why we move towards data analytics?

### Data analytics workflow outcome:

- Save time.
- Enable advanced data processing, cleaning and modifying.
- Reduce workload, avail more time for design, analysis and optimization.
- Enable maximum utilization of all available data in different format, no matter how structured it is.

### Major Challenges:

- Improve work data communication system (Data Silos).
- Enhance Data Quality Tools.
- Upgrade data utilization technologies.
- Develop tools to minimize time for collecting diverse data.



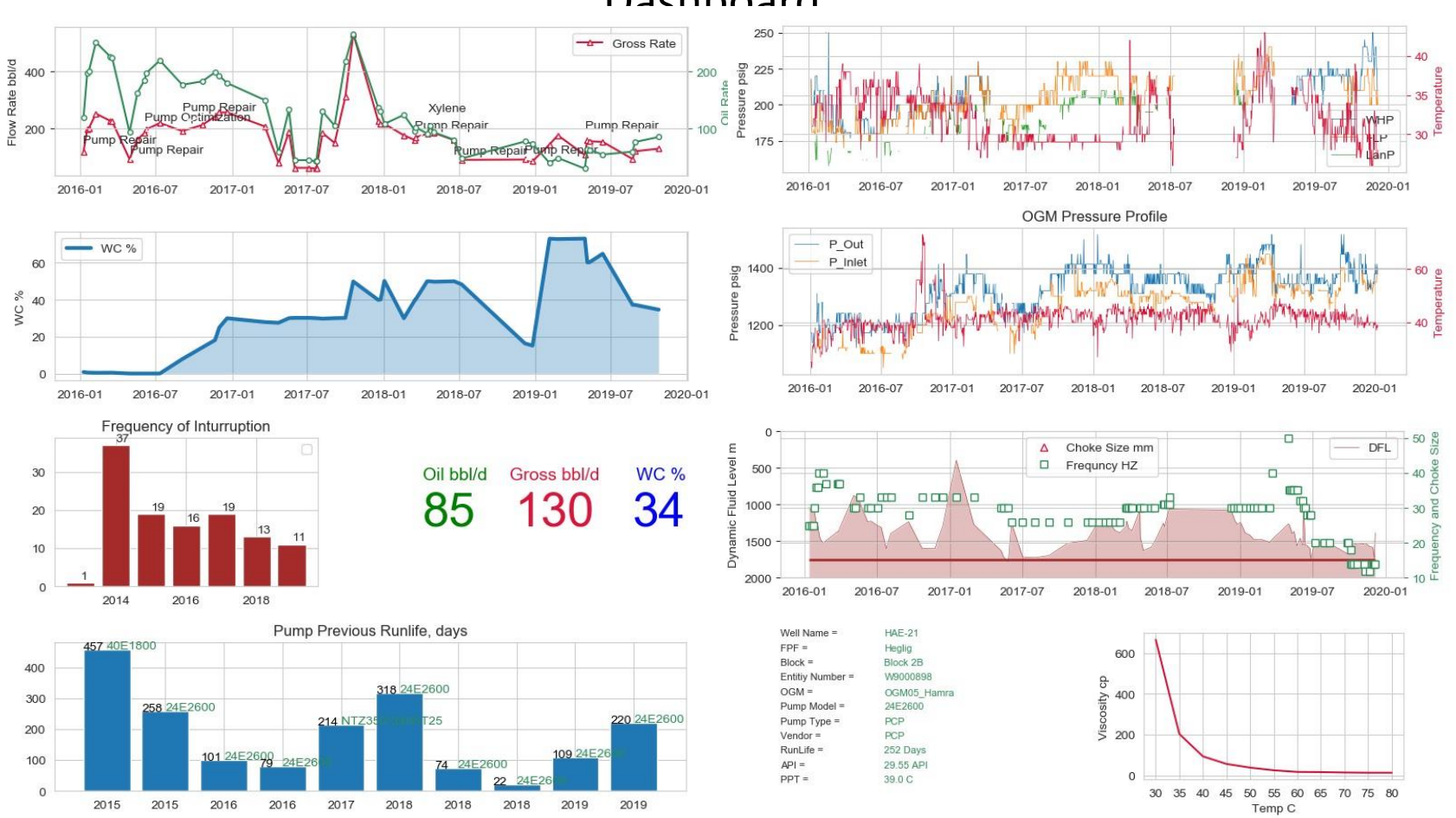
# Creating Wells Dashboard | Descriptive Analytics

## Description:

- The Well Dashboard is a result of integration of: Python, Excel, Avocet, PIPESIM and ERP.

## Added Value:

- Estimated time saving is 4 working hours Vs 1 minute run time per well.
- Scripts to remove outliers and clean the data.



# Connecting Pipeline Network with GIS | Descriptive Analytics

## Description:

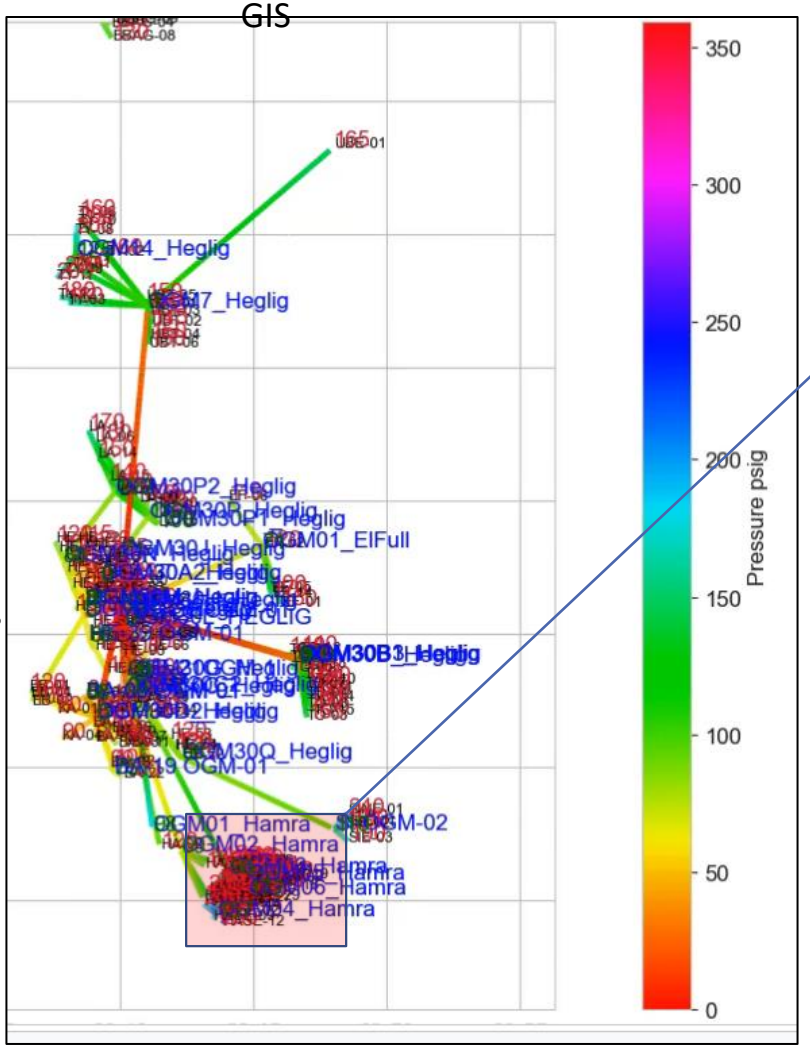
- Wells location presented using python.
- User to choose annotations:
  - Gross Rate/Temperature.
  - Outlet/Landing Pressure.
  - Flow line diameter.
- Reveal historical production data by clicking on the well on the map.

## Added Value:

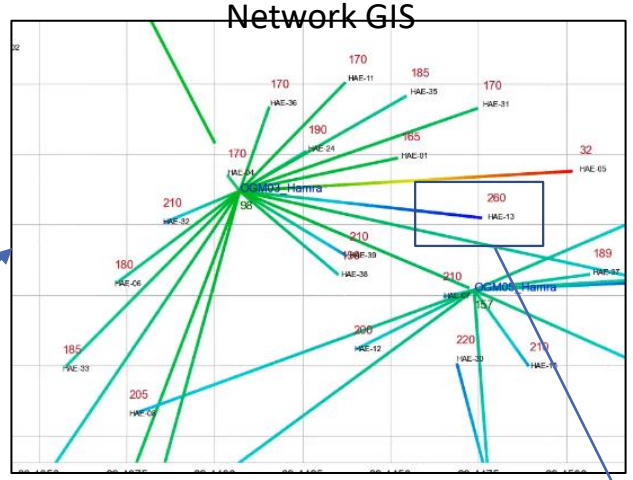
- Quick identification of (extremely difficult in traditional analysis):

1. Actual bottlenecks.
2. Gradual/instant growing up problems.

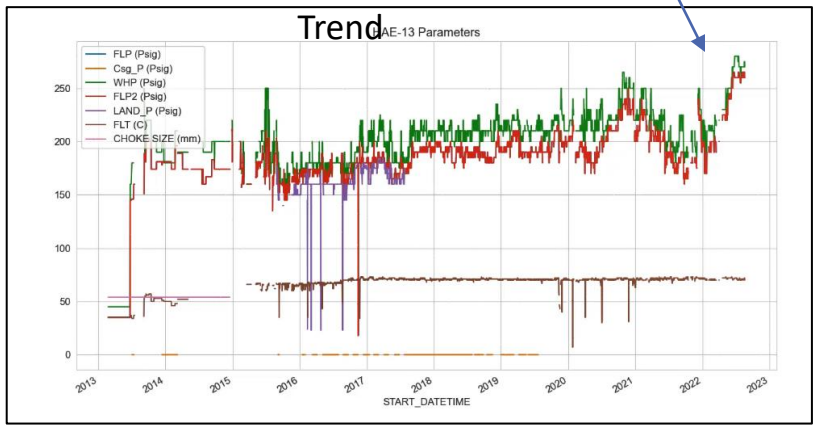
Production Network GIS




OGM Network GIS




Well Pressure Trend



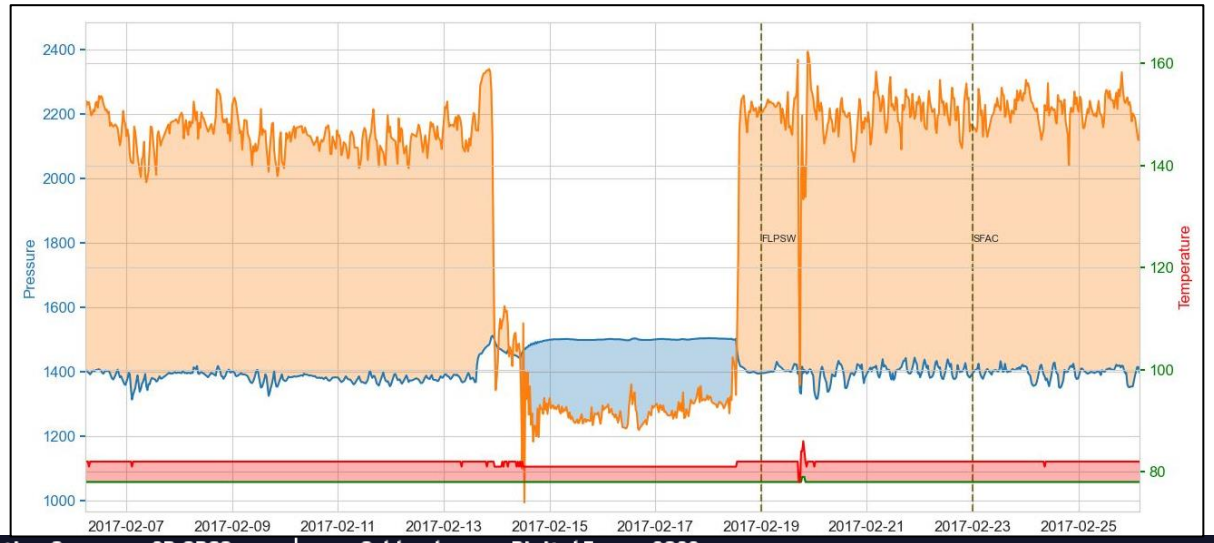
# Collecting Scattered ESP Sensor Data by Using Python Code
## Descriptive Analytics

Note:

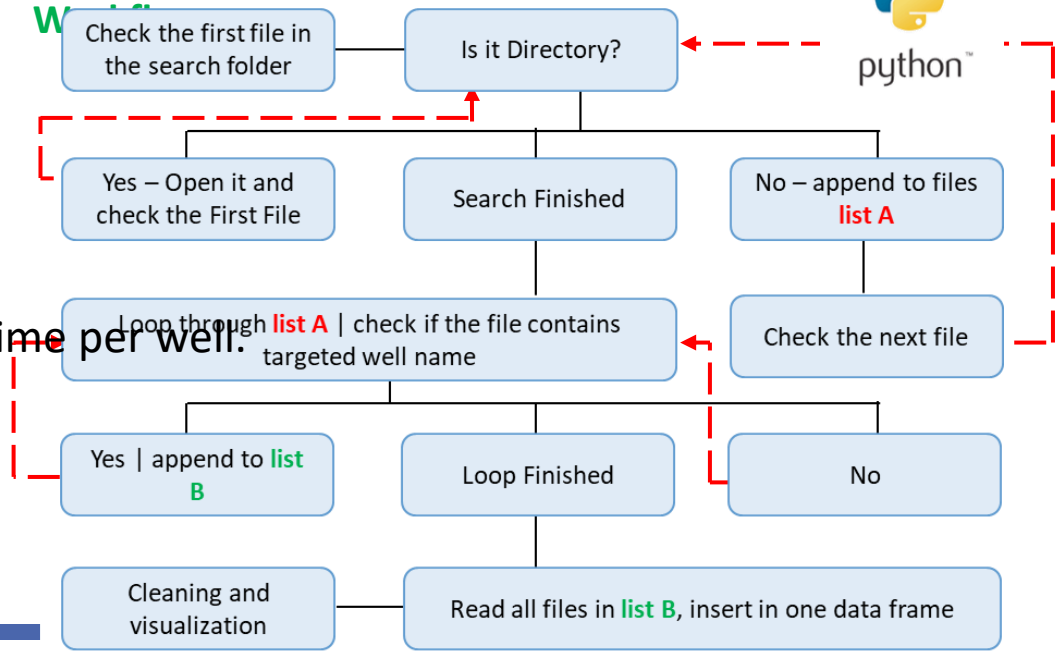
Compilation of scattered Down Hole Sensors Data files in MS Excel format from different vendors (year, month, field…etc.) is a tedious job to be extracted.

Added Values:

- Estimated time saving is 16 manual working hours Vs < 1 minute run time per well.
- Avoid human error.
- Better evaluation of workover, well performance.




Solution Workflow




```
Total Files copied are: 3554
Total Files copied for Well-1: 67
Well-1 :: 67 files has been copied successfully....
Well-1 :: 0 files failed and not copied....
```

List A

List B

```
Total Time Consumed:
--- 7.5 seconds ---
```

# PIPESIM and AVOCET Integration | Diagnostic Analytics

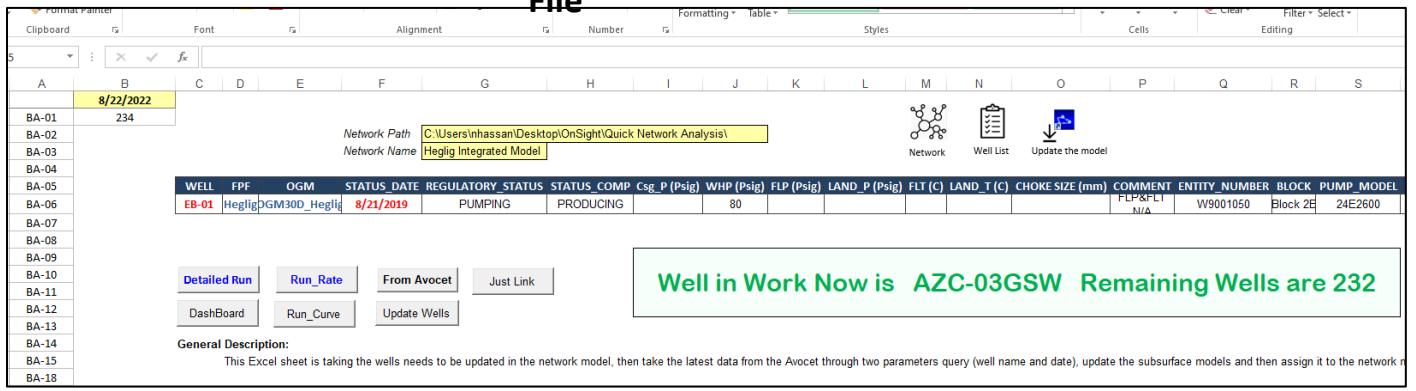
## Description:

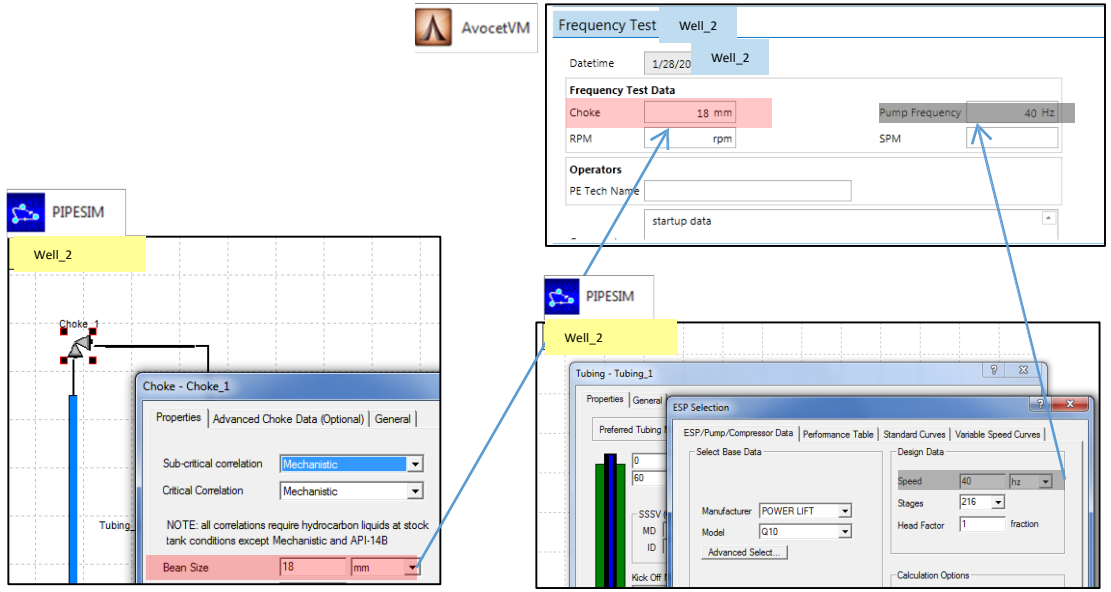
How to update existing PIPESIM data from AVOCET.

**Goal** : To update PIPESIM data by using Latest AVOCET data.

- Obtain latest data from database
- Create a loop for all wells.
- Update the subsurface model
- Connect the saved model to surface network
- Run the network model.
- Export the results to dashboard.

**Excel Sheet Update File**



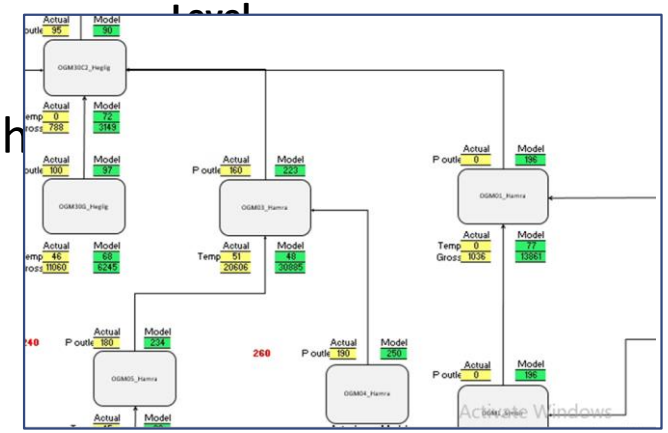



# Digital Twin in Production Network | Diagnostic Analytics

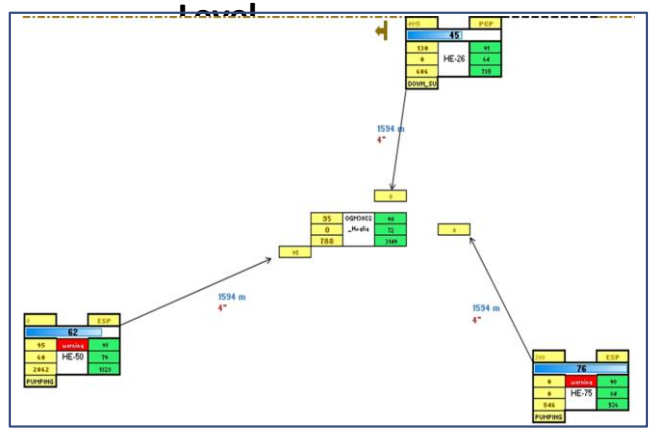
## Description:

- The updated PIPESIM models results is shown in th dashboard together with Avocet.

Production Network Level



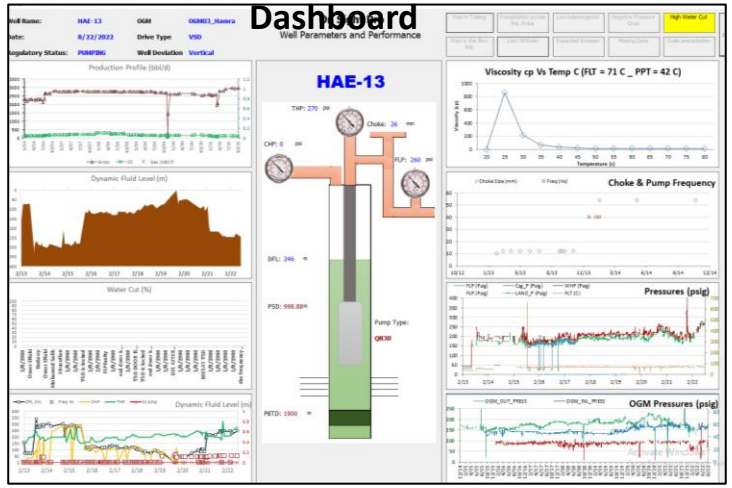
OGM Network Level



## Added Values:

- Fast, friendly and easy comparison between model result and actual.
- Reduce the time allocated for model matching by around 80%.
- Fast response in changing field conditions.
- Identify and analyze network bottlenecks to:
  1- Introduce re-routing options.
  2- Advice on chemical injection at some points.

Wells Dashboard

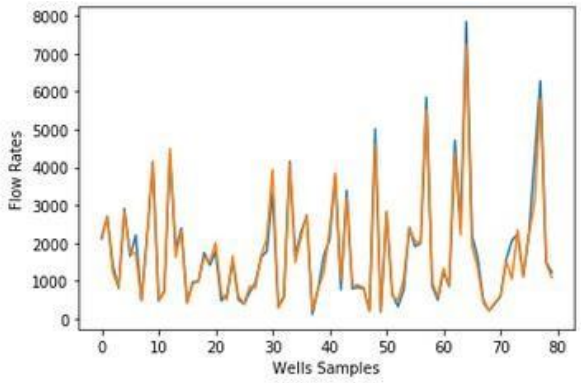


# Digital Twin for Pump Performance Analysis | Diagnostic Analytics

## Description:

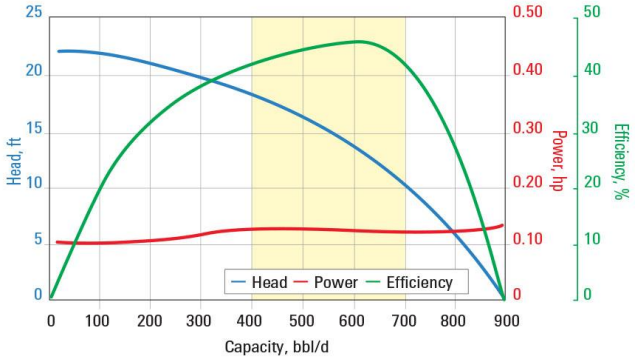
Digital Twin of Machine Learning Prediction, Theoretical and Actual Flow Rate

**Machine Learning Model Training Result |** Actual Vs Predicted Values



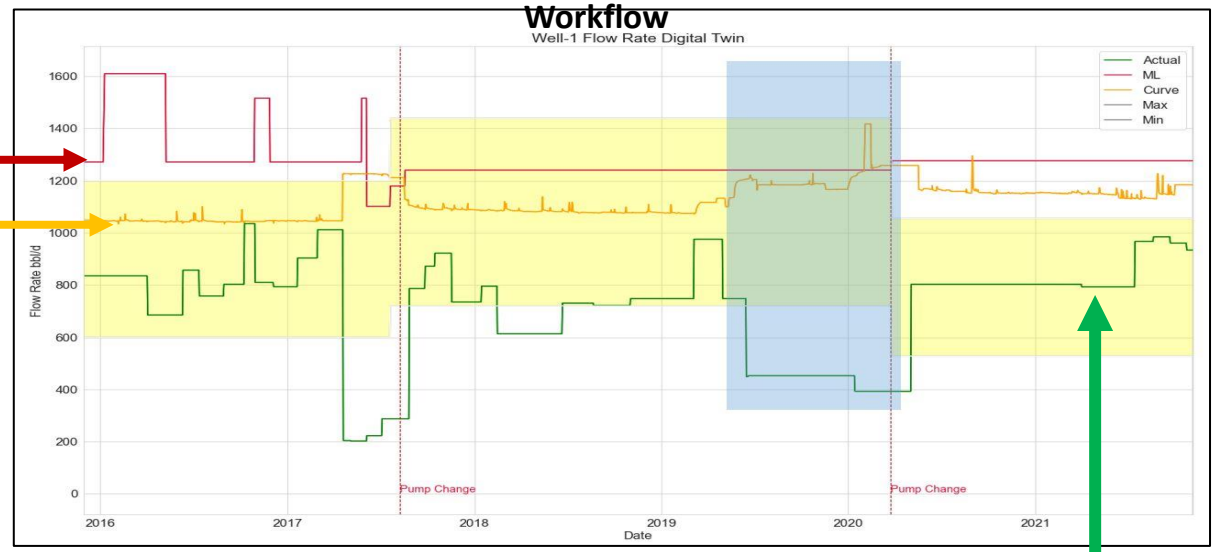

Machine Learning

**ESP Performance Curve|** Used to Predict flow rate based on sensor data




Theoretical Flow

**Well Test Workflow**




Actual Flow

AvocetVM

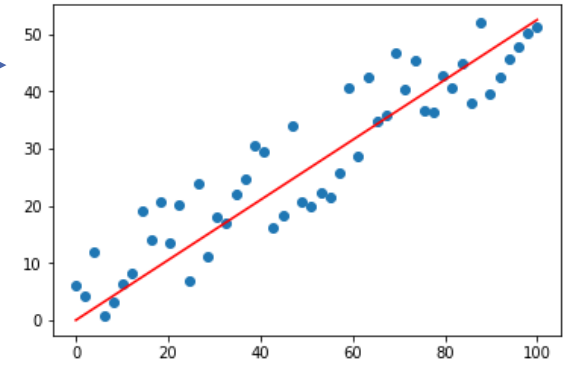
## Added Value:

- To follow proactive approach to avoid pump failure / prolong pump life time.
- Early problems identification which developed to correct / intervene at the right time.

# PCP Anomaly Detection Application | Predictive Analytics

## Automated Process (Digitalization)

RTU



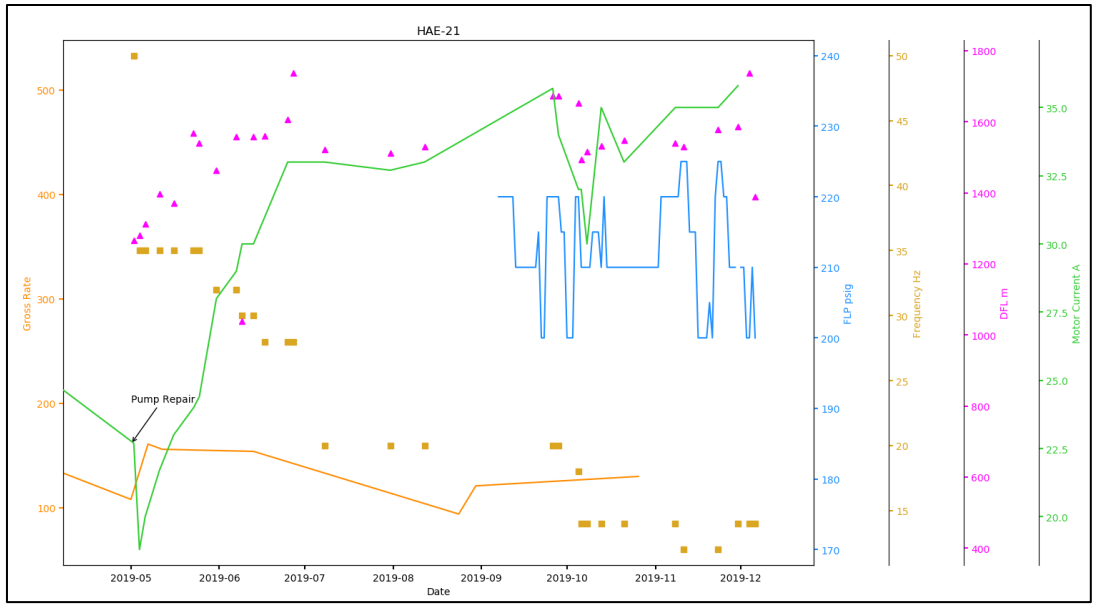
Retrieve
1- Motor elec. current.
2- Dynamic Fluid Level DFL

Run linear regression model

Classify increasing/decreasing trend

Loop through all PCP Wells

Example of Motor Current increasing Well




## Added Value:

- Automatic early problem identification, which developed to correct/intervene at the right time, through sending email to notify engineers about growing anomalies
- The workflow successfully predicted anomalies in PCP ahead of time in more than 12 cases.

# Identification of Major Zone Contributor in a Commingled Production Well | Predictive Analytics

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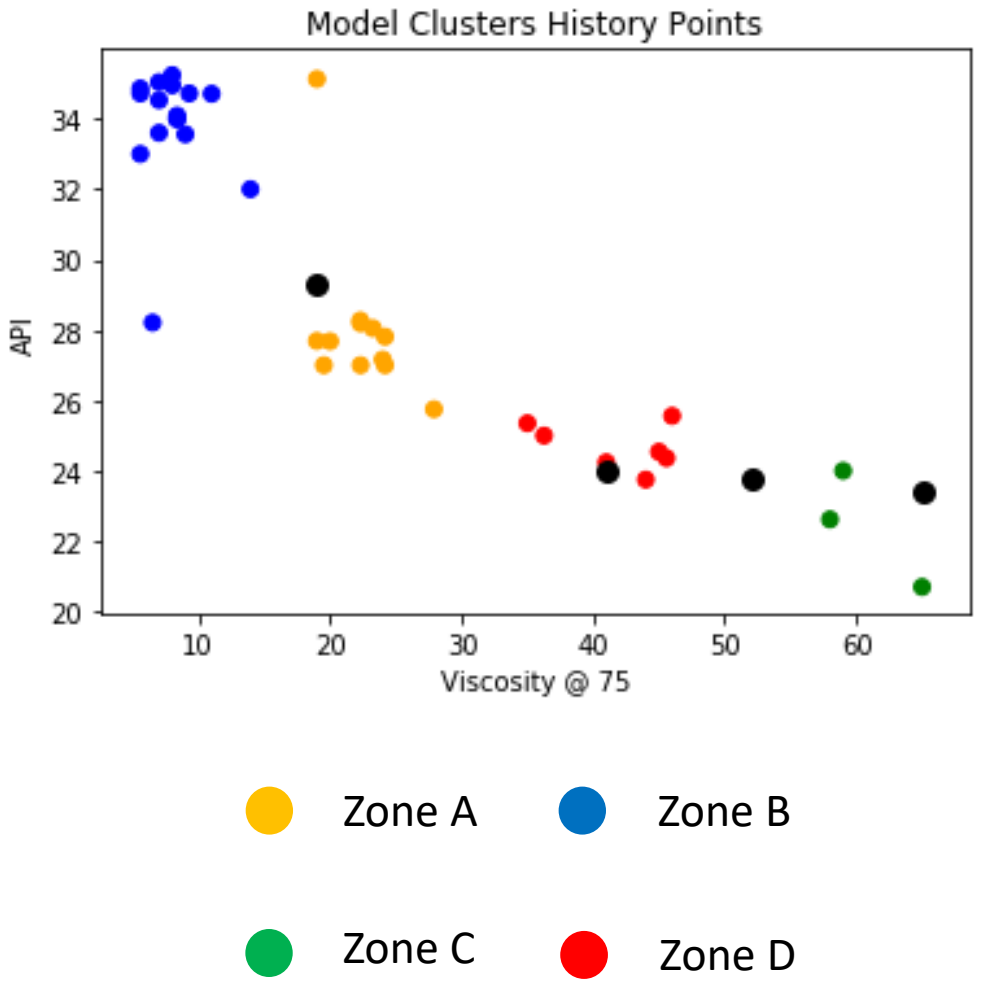
## Description:

When producing from commingled zones, one zone may not contribute as desired. In this case it is necessary to know which zone is producing more.

- K-Means clustering is used to for clustering fluid data zones origin.
- Number of clusters is set to the algorithm based on completion data.
- New data is fed to the trained ML model to identify the major zone contributing to the oil production.




## Added Values:

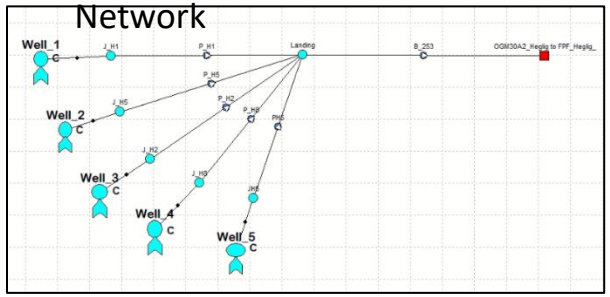
Better reservoir understanding especially in commingled production.

# ML Assisted Network Optimization | Prescriptive Analytics

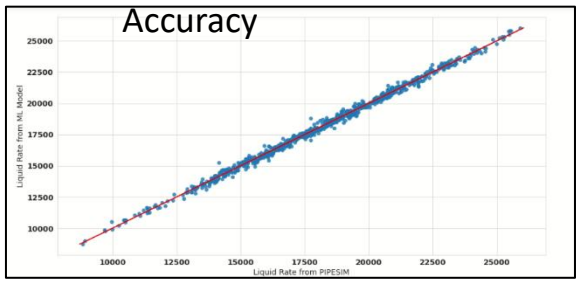
## Dataset Preparation:

Samples have been created from controlled random values (> 1 K records) that fed to PIPESIM integrated model then the PIPESIM outcome retrieved.

Small PIPESIM Production Network




Training Dataset Accuracy




**Objective Function**
Oil Rate ML Model
(Maximize)

**Final Outcome / Added Value**

| | Choke1 | HZ1 | Choke2 | HZ2 | |
|---|---|---|---|---|---|
| Initial | 30.00000 | 42.000000 | 34.000000 | 60.000000 | 10.( |
| Optimized | 36.77599 | 56.055694 | 34.200692 | 57.728471 | 45.( |

| | Initial | Optimized | Gain |
|---|---|---|---|
| Oil (bbl/d) | 786.803223 | 826.952271 | 40.149048 |
| Liquid (bbl/d) | 24394.492188 | 25303.087891 | 908.595703 |
| Temperature C | 77.208267 | 80.165413 | 2.957146 |
| Pressure (psi) | 70.403687 | 72.092224 | 1.688538 |
| WC (%) | 96.728813 | 96.761032 | 0.032219 |

Fit XGBoost ML Model (>95% accuracy)

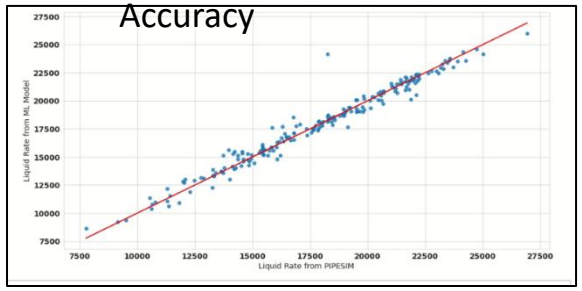
Deploy XGBoost ML Model

SciPy
Python Optimizer

Random Scenarios Generated by PIPESIM
Open Link

| Run | Well_1 Choke1 | Well_1 HZ1 | Well_2 Choke2 | Well_2 HZ2 | Well_3 Choke3 | Well_3 HZ3 | Well_4 Choke4 | Well_4 HZ4 | Well_5 Choke5 | Well_5 HZ5 | Oil | WC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 37 | 56 | 34 | 58 | 46 | 34 | 31 | 51 | 46 | 50 | 841.6641928 | 96.76750058 | 26 |
| 2 | 30 | 42 | 34 | 60 | 10 | 50 | 28 | 51 | 28 | 51 | 606.5170486 | 96.6806689 | 18 |
| 3 | 14 | 52 | 36 | 49 | 31 | 45 | 28 | 23 | 28 | 53 | 720.2141401 | 96.69710721 | 21 |
| 4 | 31 | 42 | 34 | 32 | 38 | 41 | 38 | 33 | 38 | 53 | 585.5824671 | 96.72150269 | 17 |
| 5 | 39 | 41 | 17 | 48 | 38 | 47 | 38 | 53 | 38 | 53 | 668.3782624 | 96.74015564 | 20 |
| 6 | 39 | 27 | 18 | 54 | 8 | 24 | 11 | 31 | 11 | 31 | 505.5127708 | 96.62947686 | 14 |
| 7 | 11 | 57 | 30 | 40 | 21 | 50 | 36 | 31 | 36 | 31 | 647.8466767 | 96.68786372 | 19 |
| 8 | 37 | 37 | 14 | 35 | 30 | 40 | 22 | 54 | 22 | 54 | 563.1535792 | 96.75574231 | 17 |
| 9 | 33 | 52 | 37 | 38 | 13 | 21 | 31 | 43 | 31 | 43 | 633.9437317 | 96.81111655 | 19 |
| 10 | 8 | 36 | 36 | 39 | 8 | 53 | 12 | 47 | 12 | 47 | 482.8863901 | 96.55411522 | 14 |
| 11 | 34 | 41 | 26 | 24 | 21 | 24 | 29 | 46 | 29 | 46 | 493.7648178 | 96.80133946 | 15 |
| 12 | 10 | 50 | 18 | 35 | 14 | 39 | 25 | 32 | 25 | 32 | 535.3795772 | 96.69919894 | 16 |
| 13 | 12 | 27 | 23 | 29 | 24 | 33 | 29 | 24 | 29 | 24 | 448.5463417 | 96.77999484 | 13 |
| 14 | 38 | 44 | 23 | 20 | 29 | 44 | 27 | 25 | 27 | 25 | 535.3103011 | 96.64875252 | 15 |
| 15 | 30 | 54 | 23 | 21 | 34 | 55 | 38 | 34 | 38 | 34 | 610.6455291 | 96.62099148 | 18 |

Testing Dataset Accuracy




**Bounds**
Choke and Frequency (Operable min and max)

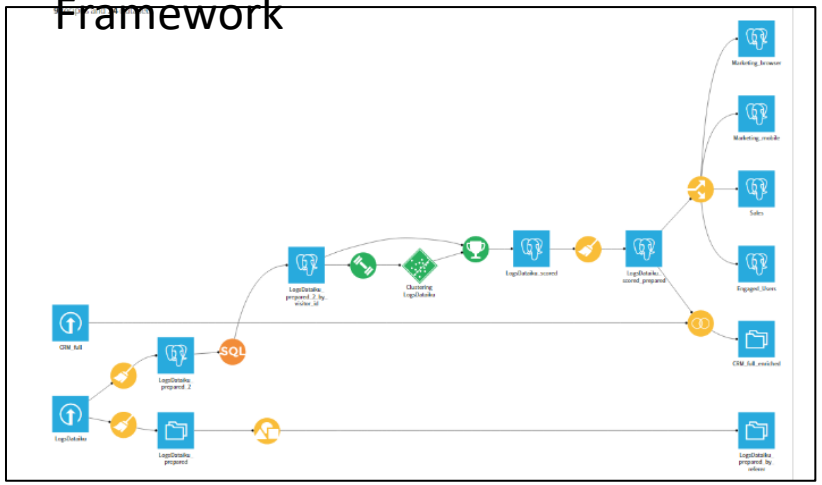
**Constraints**
Another ML Models for T and P

# The Way Forward

## Leveraging AI & ML Capabilities using Data Analytics Framework:

- Real time and sporadic data can be analyzed continuously, results can be shared in different formats (e.g. charts, reports, emails…etc.).
- Advanced workflows tools can be applied including loops, switches, different data reader and writers types.
- At the end, optimization opportunities will be captured on spot, pump trips & failures can be minimized/avoided beside a lot of other benefits.

Data iku Low Code Data Analytics Framework



## Generally:

- Talent transformation programs and specialized training are the keys for successful implementation of data analytics systems.
- “Cultural shifts in understanding AI operation and an ownership shift of vigilant monitoring and adjustment to prevent decay are all important attributes to increase maturity” **Microsoft – Digital Transformation**

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# Conclusion

- Integration of different systems open wide possibilities to reduce the cost of operation and increase the revenue.
- Data analytics helps in decisions making based on facts, minimize working efforts, cost and time.
- More efforts are needed in production optimization because it results in a direct increase in oil production.

**Acknowledgment:**

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Thank You