Big Data In Oil And Natural Gas Industry

This case study is focused on the use of big data by the oil & gas upstream industry, i. e. exploration and production activities, in a prolific European Continent Shelf. This part is rich in hydrocarbons that were first discovered in 1969, while commercial production started in 1971. Petroleum activities in the country are separated into policy, regulatory and commercial functions: the policy orientation is focused on maintaining control over the oil sector; Petroleum Directorate of the country is the regulator body, while petroleum operators compete for oil through a license system. Overall, this separation of concerns is considered the canonical model of good bureaucratic design for a hydrocarbons sector

The Challenge

The oil and gas industry is technically challenging and economically risky, requiring large projects and high investments in order to extract oil and gas. The complexity of this industry is reflected by the number of companies associated with the petroleum business – more than 20,000 according to sources. Some of them correspond to oil operators, large organizations that compete internationally, but also collaborate through joint ventures in order to share project risks. In addition, there is a multitude of vendors that sell equipment and services through the whole oil & gas value chain: drilling, subsurface and top structure (platform) equipment, power generation and transmission, gas processing, utilities, safety, weather forecasting, etc.

With the current crude price crisis situation, many large-scale projects are at risk and oil companies are looking at new ways to improve their margin costs and reduce the uncertainty of their investments – particularly through big data and data science driven solutions.

The Data Collection

Questions about the uptake of big data

- Which are your main data sources?
- What do you use the data for?
- Which are your main data challenges?
- Which are the data sharing practices of your organization?
- Which are your ongoing or future plans for open data?
- Which other parties are involved in your data value chain?
- Which are your main collaborations and data exchanges with other parties?

Questions about societal impacts of big data

- How big data is changing the oil & gas landscape?
- Which are the main legal issues with respect to big data?
- Which are the main risks with respect to policies and legal issues?
- Does your organization consider the social implications of big data
- Do you use personal or private data in your operation?
- Have you experienced any cyber-attack or suffered data leakage?

Analysis

Post interview, the transcripts of the interviews and additional data were prepared. From there particular information was extracted and classified according to relevant topics. Finally, the themes for analysis were identified based on the coding scheme and findings of the case study was obtained.

Main Data Sources:

The collected information revealed the following data sources.

Seismic data is the main source for discovering petroleum deposits. Collecting such data is expensive and typically performed by specialized companies using seismic vessels that send sound waves deep into the subsurface and a set of hydrophones to detect reflected waves. This process produces significant volumes of data, typically 100s GB per one raw dataset.

Production data is very important for oil companies and receives a lot of attention. Since this is a commercial-sensitive asset, operators do the accounting of production data by themselves. Oil production is measured at every stage of the flow, while the aggregated figures are reported to the partners in the joint venture and also to the Government that has a reporting role.

Drilling also generates high-volume and high-velocity data. This data is analyzed in real time for safety reasons and to monitor the drilling process, i. e. to detect if the reservoir is hit.

Document repositories are also quite relevant in the oil & gas industry and employed in different stages. For example, post-drill reports can be analyzed to obtain the rock types in a well – this can be relevant for other analogue areas under exploration. However, document repositories are typically unstructured and quite varied since a report could be produced anytime from the beginning of oil operations.

Usage of Data

With such massive data assets collected in the oil & gas industry, there are a number of uses of data in place, and described in the following paragraphs, organized around the different stages of the upstream value chain.

- **Exploration and scouting**

Seismic processing for the discovery of petroleum is the classical big data problem of the oil & gas industry. Operators have made large investments in high-speed parallel computing and storage infrastructures to generate 3D geology models out of seismic data. The resolution of the images obtained with seismic data is low [9], and for this reason petroleum experts (geophysicists and petrophysicists) try to use additional data sources such as rock types in nearby wells and images from other analogue areas. Nevertheless, the complexity of exploration data makes the access of data to petroleum experts especially challenging, requiring ad hoc querying capabilities.

- **Production**

Seismic data is also employed in production for reservoir monitoring, creating 3D models of the reservoir in subsurface. Simulations are then carried out to evaluate how much oil should be produced in a well. Nowadays, there is a trend to permanently deploy seismic sensors in the seabed of a reservoir allowing the detection of microseismic activity. In addition, seismic data from producing fields can be employed to discover oil. pockets that can result in more wells for
drilling and thus extend the lifetime of a field. Finally, production data is carefully accounted through all stages of the petroleum workflow.

- **Drilling and wells**

Drilling operations are normally contracted to specialized companies. Oil operators get the raw data from drilling contractors and then select the target for drilling and decide whether to continue or not, sometimes relying on simulators [I-CP]. These decisions are based on the analysis of drilling data, and they aim to minimize the non-productive time of very costly drilling equipment and crews.

- **Operations**

This is possibly the most interesting area in oil & gas in terms of big data]. It consists of structured data that is very varied, ranging from 3D models to sensor data. Velocity is also challenging due to the large number of sensors involved producing data in real time. In addition, there are lots of technological opportunities, e. g. Internet of Things. The main drivers for applying big data here include the reduction of well downtime, improving the lifetime of equipment and reducing the number of staff offshore. Among the different uses of data in operations, condition-based maintenance is possibly the one that is receiving more attention. Equipment is instrumented to collect data and analytics are then applied for early detection of potential failures before they occur. Condition-based maintenance is thus much more efficient than traditional reactive or calendar-based approaches. Both operators and suppliers are interested in reducing costs and improving the lifetime of equipment; as a result, there are a number of ongoing collaborations to support condition-based maintenance. Vendors are also analyzing operational data to improve the efficiency of equipment, e. g. using less energy to control the same piece of equipment. The analysis of operational data can also lead to new data driven products. Other opportunities in operations include data-enabled services such as failure detection or vibration monitoring. Integrated operations is another application area that aims to combine data from multiple sources, e. g. operations and production data, and then use analytics to leverage decision-making processes.

Conclusion

The oil & gas domain is transitioning to a data-centric industry. While big data still needs to prove its effectiveness in oil & gas, the industry is beginning to realize its potential and there are many ongoing initiatives, especially in operations. In this case study a number of economical impacts associated with the use of big data in oil & gas were identified: data generation and data analytics business models are beginning to get traction, there are a number of commercial partnerships around data and the national regulator has embraced open data in order to spur competition among oil operators. However, companies are still reluctant to share their data, despite some emerging initiatives. Moreover, existing business models have to be reworked in order to promote the adoption of big data.

On the positive side of social and ethical impacts, safety and environment concerns can be mitigated with big data, personal privacy is of low concern in oil & gas and jobs are created for data scientists – whereas operators and other types of jobs might be less in demand. On the negative side, cyber-security is becoming a serious concern and there are trust issues with third-party data and data-driven analytics.

The petroleum industry benefits from a mature regulation framework in Norway, although regulation of data requires further clarification. Additionally, companies are increasingly aware of the value of data and we can expect contention about data ownership. Many companies in the oil business are multinationals, so there is a need to harmonize international legislation with respect to data. Indeed, some vendors are becoming leaders in big data, and the rest should embrace big data in order to succeed in the future.