Digital transformation prospects for the offshore project supply chain in the Russian Arctic

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Abstract. The article provides a comparative digital maturity assessment of two leading petroleum companies licensed for Arctic offshore exploration and production (PAO Gazprom Neft and PAO Rosneft) in a ‘hardware-software-hardware’ succession as well as a comparative analysis with leading practices in offshore project logistics. It identifies approximate cost-cutting limits of digital transformation in Arctic projects and factors limiting cost efficiency of offshore projects in the Russian Arctic. The goal of the study is to identify a potential increase in digital maturity and scope of digital transformation in the Arctic project supply chain in Russia. The study is based on modern approaches to sustainable supply chain management in oil industry and supply chain streamlining for offshore projects. The article identifies a group of factors limiting cost efficiency of Arctic projects, specific to the Russian Arctic. Conclusions and recommendations: the study has shown that the main factor limiting digital transformation of offshore projects in the Russian Arctic is the increasing technological underperformance of oil service companies. To build capacity in digital maturity of the offshore project supply chain, it is necessary to focus on disruptive technologies that could significantly lower the cost of oil production in the Arctic area.

1. Introduction

For a long time, the oil and gas industry has been significantly lagging behind in matters concerning digitalisation compared to other sectors, such as metallurgy, chemical production, machinery, and hydrocarbon processing. However, the development of rich but hard-to-recover Arctic hydrocarbon resources demanded making a qualitative leap in creating value and changing the business models. In fact, digital transformation along the whole supply chain for offshore projects is becoming crucial for competitiveness (Fig. 1).

However, digital transformation processes have been put in more difficult circumstances because of the increasing sanctions. In particular, the high dependence of offshore projects in the Russian Arctic on imported equipment may lead to a significant increase in oil production costs because of the sanctions. It is therefore necessary to assess digital transformation processes in the offshore project supply chain from the standpoint of potential production cost cuts, which means an assessment of digital maturity of the leading Russian oil and gas companies licensed for offshore operation in the Arctic and analysis to compare them with leading practices in offshore project logistics.
Authors researching digital transformation issues include: Schrauf, S.; Berttram P. [29]; Geissbauer, D.; Vedso, J. [22]; Martin, P.; Kanterm, R. [25]; Reiner, A.; Gausemeier, J.; Michael, T. H.; Wolfgang, W. [30]; Baculard, L. [18]; Beier, G.; Niehoff, S.; Ziem, T. [19]; in particular, oil and gas complex: A. Alekseyev [2]; D. Kozlova [4]; D. R. Peskova [27]; Xinquan, R.; Yulong, G.; & Shilong, C. [33]; Brun, A.; Zharkeshov, S. [21]; Mittal, A.; Slaughter, A.; Sansal, V. [26]; Bean, G. [32]; Brantley, J. [20]; Zhilin, Q.; Lei, C.; Dengsheng, L. [34].

Several foreign scientists have had a significant impact on supply chain development in oil and gas: Liew, K.; Lee, C. [24]; Ahmad, W.; Rezaei, J.; Tavasszy, L.; de Brito, M. [16]; Saad, S; Udin, Z.; Hasnan, N. [28].

2. Findings

Successful supply chain planning lies not in managing each link separately but in overall planning and streamlining. The very nature of oil and gas industry is complex, capital-intensive, and risky. Full transparency and full control of the whole supply chain are critical for resource efficiency and profit increase opportunities.

Figure 1. Supply chain of oil and gas enterprises

Implementation of Arctic projects is connected with a whole lot of adverse factors significantly increasing production costs (Fig. 2).

These factors can be roughly divided into two groups: factors affecting the overwhelming majority of Arctic projects (nature, infrastructure, geology, environment, and technology) and factors specific for projects in the Russian Arctic. In the recent years, most of them have exacerbated the cost efficiency situation due to the increased pressure from the US sanctions, thereby creating obstacles for offshore oil development in the Arctic [1], [10].

Taken as a whole, these factors determine a considerable increase in capital investment needs throughout the offshore project supply chain and therefore require an accelerated digitalisation to ensure suitable cost efficiency for production in “difficult” fields [5].

In fact, we can talk about a digital transformation, i.e. changing the business models and management approaches based on digital platforms, which leads to a significant growth of market volumes and/or increased competitiveness of companies [4].
The essence of digital transformation is in the crack spread, which means the price differential between the price of crude oil and petroleum products, reflecting the profit margin of an oil refinery. It is normally calculated in USD per barrel of petroleum products. The indicators are directly related: the higher the crack spread (margin), the more efficient the production processes.

It is the digital transformation that ensures a maximum crack spread, based on [13]:
- increased fail-safe operation of equipment;
- shortened idle time resulting from unplanned maintenance and repair (M&R);
- improved operational efficiency;
- safety for the personnel and public.

Implementation of information technologies (IT) is becoming critical for oil and gas companies. The easily accessible oil reserves are depleting, with the share of hard-to-recover reserves on the rise, which determines the lower recovery factor and makes companies change their methods of resource exploration and production [15].

According to estimates of the Oil and Gas Institute of the Russian Academy of Sciences (IPNG RAN), the oil recovery factor is 29% using conventional technologies, 38% using digital technologies, and 47% using smart technologies.

It is reasonable to single out the following key effects of digital transformation for oil and gas companies [6, p.16; 14]: increased fail-safe operation of equipment;
- shortened idle time resulting from unplanned maintenance and repair (M&R);
- improved operational efficiency;
- safety assurance for the personnel and external stakeholders.

To assess the level of digital transformation in leading Russian oil and gas companies carrying a state licence for offshore operation in the Arctic, PAO Gazprom Neft and PAO Rosneft have been analysed throughout their offshore supply chain (Table 1).

The development and implementation of Gazprom Neft’s and Rosneft’s corporate digital transformation strategies triggered a considerable increase in digital maturity and helped to create unique solutions in the industry as a whole.
Table 1. Comparative analysis of some innovations in digital transformation for PAO Gazprom Neft and PAO Rosneft, 2018–2019

| Phase                  | Stage                        | Rosneft                                      | Gazprom Neft                                  |
|------------------------|------------------------------|----------------------------------------------|-----------------------------------------------|
| Exploration            | Geological prospects         | Geological modelling software suite          | TsAVGI (Digital Centre for Analysis and Visualisation of Geological Information) |
|                        | Seismic modelling            | Cloud technologies for seismic data processing and interpretation; 3D model for development of hard-to-recover gas reserves | AI-based digital modelling                    |
|                        | Geological exploration drilling | Geological modelling software suite          | Drilling precision software development       |
| Development            | Development planning         | ---                                          | Cognitive Engineering Programme               |
|                        | Design and construction      | Hybrid Twin and Digital Twin models          | Predictive M&R for production facilities      |
|                        | Operational drilling         | Hydraulic fracturing simulator                | Self-learning software for cost efficiency in drilling complex horizontal wells |
| Production             | Well completion              | Post-fracturing well bottom cleaning         | Remote drilling control centre                 |
|                        | Production                   | Microbial preparation for hydrocarbon contamination in northern seas | Digital Drilling programme (Gazprom Neft)     |
|                        | Well intervention and workover | ---                                          | Production Management Centre digital system   |

The results of the comparative quantitative assessment of disruptive digital solutions show that Gazprom Neft is currently ahead of Rosneft in the rate of innovation in most of the implemented oil and gas programmes, which is explained by a closer focus on digital transformation in the implementation of the Russian Energy Strategy until 2030 as well as its more significant digitalisation track record [12] (Table 2).

An important element of the Rosneft-2022 strategy is digitalisation, which includes the Digital Field, Digital Factory, Digital Supply Chain, and Digital Fuel Station programmes. Combined, they will help to cut costs, use resources more efficiently, and boost business development.

In this respect, Gazprom Neft can be considered the leading company in the Russian oil and gas sector as far as digital transformation is concerned. To identify the company’s position on the global market, we did an analysis comparing it with leading practices in the sector.

Table 2. Comparative analysis of disruptive digital solutions implemented by PAO Gazprom Neft and PAO Rosneft

| Core programmes                  | Maturity assessment (1-7)* | Rosneft’s core programmes                                           |
|----------------------------------|----------------------------|---------------------------------------------------------------------|
| Cognitive Geologist              | 5.5  | 4.0  | TsAVGI (Digital Centre for Analysis and Visualisation of Geological Information) |
| Cognitive Engineering            | 4.5  | 2.5  | Predictive M&R for production facilities                           |
| Project Management Centre        | 4.5  | 3.5  | Remote production centre                                          |
| Digital Drilling                 | 4.5  | 4.5  | Remote drilling centre                                           |
| Production Management Centre     | 5.5  | 4.5  | Remote production centre                                          |
*1- a planned scenario; 2- a developed concept; 3- a feasibility study for pilot (prototype) technology; 4- an approved technical and economic project plan; 5- a launched pilot project; 6- a successfully implemented pilot project; 7- implementation of technology in production

As digital transformation criteria, we used the stages of the **software-hardware-software** cycle, where digital transformation is assessed as a sequence of phases, from a digital record to using algorithms and automation devices [6], [9] (Fig. 3).

The accelerated digitalisation of Gazprom Neft and implementation of the Cognitive Geologist, Project Management Centre, and Digital Drilling programmes helped to close the technological gap in Exploration and Development.

It still insignificantly lags behind in Production. The benchmark company is Norway’s Econor, which has been using an automated rig since 2018 in the Oseberg field, North Sea. In mid-term run, it will lower the break-even threshold from 34 to 16 USD per barrel.

Shell can be considered the leader in Well Intervention and Workover. It implements its **Sensabot** programme that remotely controls robots capable of functioning in hazardous locations [11].

![Figure 3. Current digital maturity level and short-term digital technology plans in exploration and production [6]](image)

There are still no full-scale digital platforms covering the whole value creation chain in the oil sector, and Gazprom Neft has an opportunity to become one of the world leaders in digital transformation of the oil sector. It is very likely that the platform will encompass the Prirazlomnaya project, the only full-scale offshore project in the Russian Arctic [2].

To show digital transformation better, we used the average values for the Smart Field technology. The technology is considered mature enough and has been used by leading petroleum sector companies like BP and Shell since 2004 and since 2008 in Russia [4] (Table. 3).

**Table 3. Efficiency of the most popular smart field/well technologies**

| Developer | Technology               | Reserve/production impact | Cost efficiency impact |
|-----------|--------------------------|---------------------------|------------------------|
| Shell     | Smart Field              | Oil RF, to +10 %          | Idle time, to -10 %    |
|           |                          | Gas RF, to +5 %           | Expenses, to -20 %     |
| Chevron   | i-field                  | Oil RF, +6 %              | -                      |
|           |                          | Production, +8 %          | -                      |
| BP        | Field of the future      | Production, +1-2 %        | -                      |
| Petro     | Smart Operation          | -                         | Capex, -50 %           |
| Statoil   | Integration Operation    | Production, +20 %         | -                      |
| Halliburton | Real Time Operation  | -                         | Capex, -20 %           |
In general, the digital transformation strategy lets the Russian market leaders cut their specific operation expenses by 2–3% and reduce the drilling time. However, it is not sufficient for the significant cost of potential offshore projects in the Russian Arctic. For instance, according to OOO Gazprom VNIIGAZ data, the average breakeven oil production level in four areas off the coast of the Yamal Peninsula was from 141 to 158 USD per barrel in 2013. Following the sanctions, the figures have considerably changed. For example, according to Saudi experts, Russia has to keep the critical Brent threshold of at least 40 USD per barrel in 2020 [4], [8].

At the same time, the World Bank projects that implementing the Digital Transformation scenario will have significantly reduced hydrocarbon prices in the mid-term run (to 40.0 USD per barrel by 2030) mainly because of a significant supply increase [7]. According to the Russian Energy Minister Kirill Molodtsev, oil prices will be varying in the $100–150 range by 2020 provided the optimistic scenario [5].

| Scenarios          | 2016 | 2017 | 2020 | 2025 | 2030 | 2035 |
|--------------------|------|------|------|------|------|------|
| Status quo         | 45.7 | 55.9 | 59.3 | 58.6 | 57.7 | 57.12|
| Digital transformation | 45.7 | 55.9 | 59.3 | 53.9 | 46.4 | 40.0 |
| Change             | 0 %  | 0 %  | 0 %  | 8 %  | 20 % | 30 % |

Thus, at the current stage of digital transformation in leading oil companies, it is only possible to assess the offshore digital transformation prospects in direct correlation to technological advancement prospects in the sector. According to an analytical company, the dependence of the oil and gas sector on imported equipment is between 80 to 98%, thereby bringing offshore projects close to the upper limit of dependence [4].

Before the sanctions, Russia used to buy oil and gas equipment mainly from American and European suppliers. Now, specialised equipment is supplied to the Russian energy sector by Asian countries like South Korea and China, whereas the only Russian equipment that can be used for offshore drilling is welding equipment and other insignificant parts [3].

Russian oil service companies are increasingly lagging behind the competition in terms of technologies and therefore incapable of making state-of-the-art equipment for successful Arctic offshore operation in the mid-term perspective.

The technological gap puts an additional cost on offshore projects in the Arctic. Currently, all Arctic projects are shared between Gazprom and Rosneft. In accordance with the same licence obligation, Russian licence holders have to drill 130 exploration wells by 2030, with 27 wells in 2021 alone.

Thus, the projected widening of the technological gap and high probability of falling hydrocarbon prices in the mid-term perspective will greatly increase the cost of new offshore field exploration in the Russian Arctic, making production fields highly improbable.

In this respect, we can identify the following sequence of offshore project implementation in the Arctic, shown in Fig. 4 [3]:

![Figure 4. Implementation algorithm for offshore projects in the Russian Arctic](image-url)
- exploration of partially onshore fields with a developed infrastructure (Kharasavey field);
- in the ice-free part of the Barents Sea;
- using cheap (including remote) exploration methods for Arctic sea reserves;
- drilling several appraisal wells (possibly by several companies).

3. Conclusions
In the context of this study, we need to note that the absence of new promising offshore projects in the Russian Arctic shows a number of negative consequences for digital transformation in the supply chain:
- reduced scalability of domestic digital solutions;
- increased cost of domestic digitalisation development;
- lack of sufficient incentives to become world leaders in digital transformation.
We believe that to boost digital maturity in the offshore project supply chain, it is necessary to focus on disruptive technologies that will significantly reduce the cost of oil production in the Arctic area.

4. Further research
The study can be potentially expanded based on a scientific analysis of methodological and conceptual issues of including disruptive technologies into offshore project supply chains in the Russian Arctic under the pressure from the sanctions. Given the resource-orientated Russian exports and prevalence of the oil and gas sector in the federal budget revenue structure, offshore projects in the Arctic may serve as groundwork for use and further distribution of disruptive technologies in related areas and a basis for an innovative upgrade of the onshore Arctic infrastructure.

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