

AI in oil and gas

Extracting collective value
by humanizing data



EY

Building a better
working world



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A sector under siege

The Canadian oil and gas sector is experiencing one of the deepest and longest recessions we've seen in decades. Four years of low commodity prices, forecasts of the looming peak oil demand, and the increasing pressure of moving toward sustainable energy sources have combined to put the entire sector on notice that change is happening, right here, right now.



To make matters worse for Canadians, the price differentials caused by lack of pipeline access to tidal waters and US markets onshore have been wider than ever – at one point, West Texas Intermediate (WTI) was trading at approximately US\$70/boe and Western Canadian Select at approximately US\$20/boe. This effectively meant Canadian crude was being sold at approximately a US\$50 discount compared with other markets, costing the industry, federal and provincial governments an estimated US\$80m every day.

Amid the downturn, 56 Canadian oil and gas companies filed for bankruptcy between 2015 and 2017. In Alberta alone – the heart of the Canadian oil and gas sector – 45,200 jobs were terminated from 2014 to 2017. Many of those who lost their jobs left to other sectors or other parts of the country, seeking new employment, retraining in new skills and capabilities, never to return.

Executives in the oil and gas sector have expressed concern that the remaining workforce are the older, more skilled workers, closer to retirement, with younger, more adaptable workers moving on to fresh pastures, potentially creating an aging workforce problem that will likely peak in the next 5 to 10 years.

An aging, depleted workforce and the relentless pressure on operational efficiency creates an opportunity for technology to play an even greater role in the Canadian oil and gas sector going forward. Can humans and AI bring hope to a sector under siege? We believe so. In fact, we believe it has to happen for the industry to continue to prosper.



Lance Mortlock
Canadian Leader, Oil & Gas
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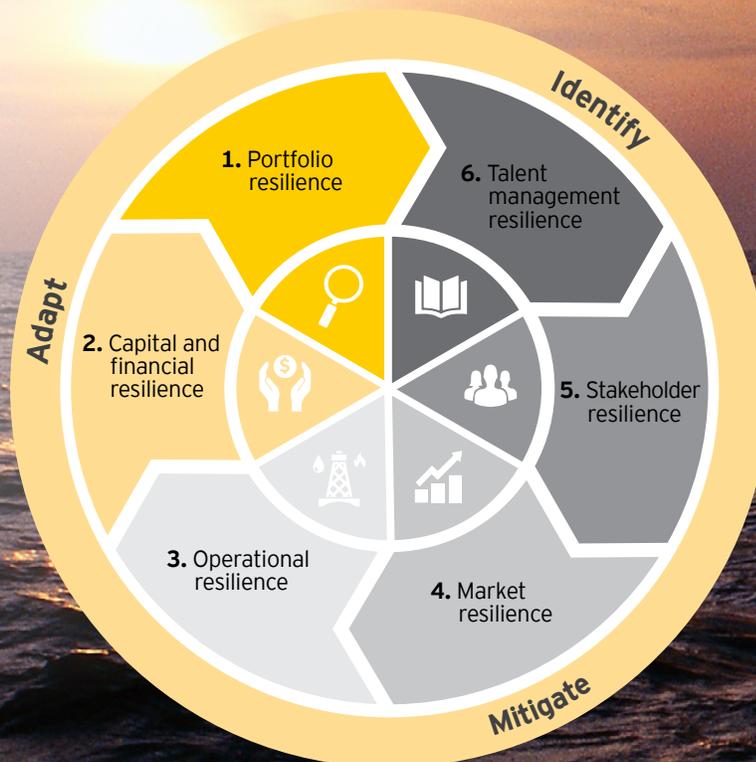
Business resilience and cost management to the fore

As a consequence of these business challenges – including crude prices, market access, talent and operating costs – companies have developed a **laser focus on business resilience and driving costs** down using all the tools at their disposal.

Business resilience is the strategic organizational capability to mitigate and adapt to disruptive and destructive threats, reshape environments, and survive both foreseen and unforeseen risks.

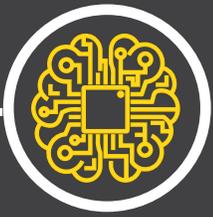
To achieve resilience and thrive, a company's strategies must be fit for purpose, based on sound analysis and ensure each element works in concert with the others. Any resilience capability must be built to continually adapt to changes in the business and external context.

The Canadian oil and gas sector has doubled down on managing business resilience with a focus on six critical components: portfolio, capital and financial, operational, market, stakeholder and talent resilience. But has the sector done enough? And are there untapped opportunities using new technologies?



The background of the slide is a photograph of an offshore oil rig at dusk or dawn. The rig's complex steel structure, including cranes and towers, is silhouetted against a dark, gradient sky. A small flame is visible at the top right of the rig. The overall mood is industrial and dramatic.

Companies have developed a **laser focus** on **business resilience** and **driving costs** down using all the tools at their disposal.



Applying AI and machine learning in a cost-constrained environment

When it comes to new technologies, there's often a lot of hype around their capabilities. But with artificial intelligence and machine learning (AI/ML), paradoxically, the potential opportunities and benefits are still, if anything, under-hyped.

Often, the impact of new technologies is overestimated in the short term and underestimated in the long term. And while there's a lot of noise regarding AI/ML, there's been a lack of in-depth discussion and analysis of how it's actually going to transform businesses.

Most organizations aren't exploiting the potential of AI/ML; they're just at the start of their AI/ML journeys. Logically, what should be holding companies back is a lack of talent. But, in fact, it's a lack of understanding of the possibilities – particularly among executives of larger enterprises.

The oil and gas sector at large has invested proportionally less on digital and AI/ML-related technologies in the last decade compared with other sectors, such as banking, automotive, health care, retail and consumer products, and software. This is partly because it's seen as risky, unproven technology and it requires highly skilled programmers and data scientists. But it's also because it requires a sustained, long-term investment of dollars that many companies simply couldn't afford during the downturn.

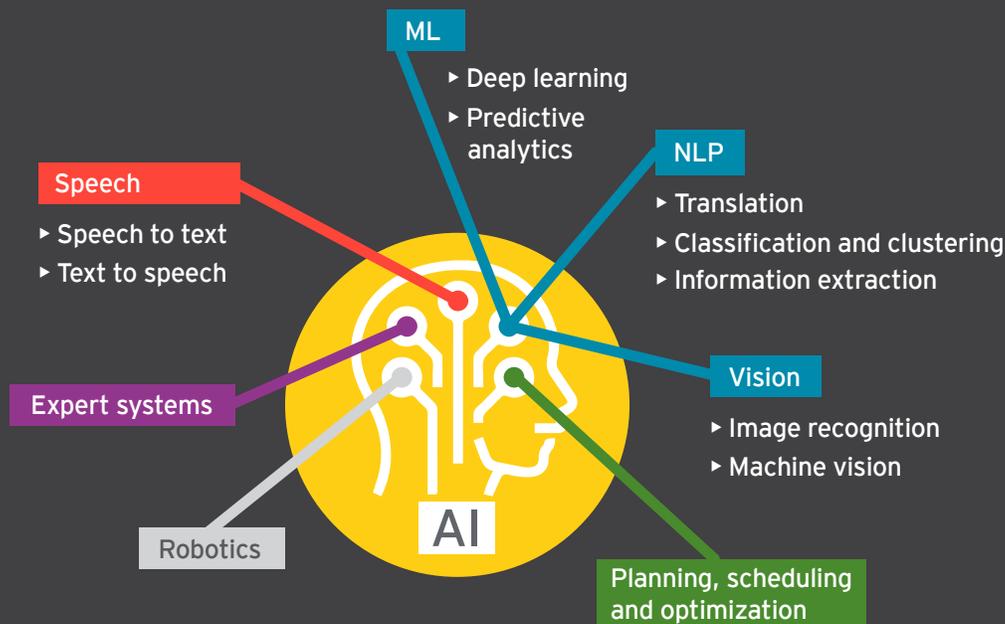
In addition, digital fluency and the use of AI/ML technologies have not been seen as core competencies in a sector that's long been ruled by human operators – namely, mechanical, chemical and electrical engineers. Early adopters are typically sectors that are comfortable with digital fluency and those that have access to standardized data sets.

What is AI?

AI is a collection of technologies that includes ML, natural language processing (NLP) and robotics that allow machines to sense, interpret, act and learn on data to aid decision-making.

Why does it matter?

AI will disrupt and transform the relationship between people and machines, and drive greater productivity in businesses.



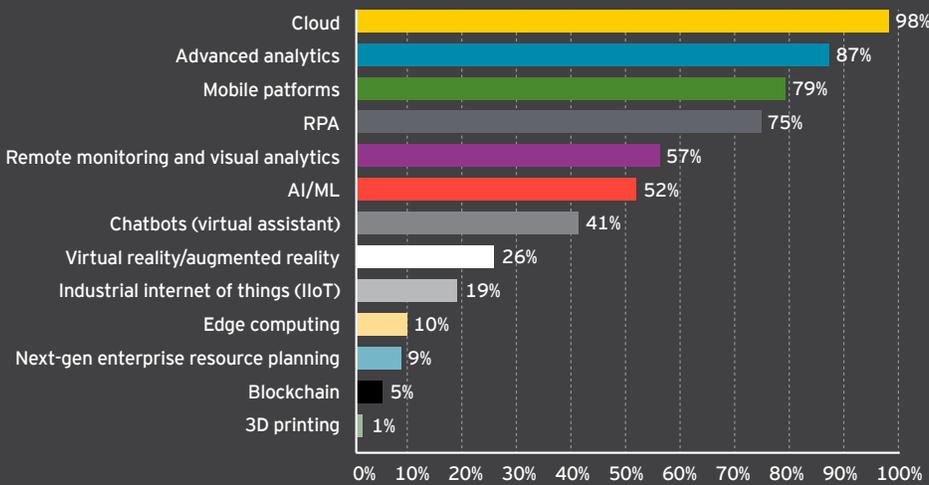


In a 2018 survey of seven global oil and gas super majors, EY asked which technologies they were currently implementing – and AI/ML didn't even rank in the top five responses. We also asked which technologies they expected to have the greatest positive impact on their businesses over the next five years, and AI/ML still featured last. The respondents predicted that robotic process automation (RPA) (25%) and advanced analytics (25%), but not AI/ML, will have the most significant and positive effect on their businesses.

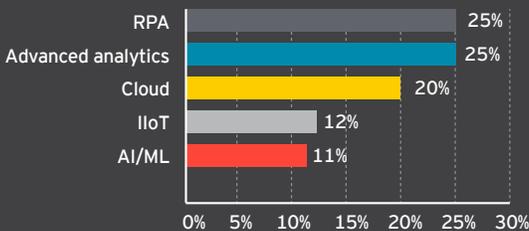
Leaders in the oil and gas sector risk being blindsided by not considering the potential of AI advancements. Given the pressure to survive in the Canadian oil and gas sector, companies are likely to seek new ways to reduce costs, add capacity and capability, speed up decision-making and improve quality, while managing risk.

AI/ML has the potential to come to the fore, allowing humans and machines to work together in collectively intelligent ways in support of these business drivers, creating the opportunity to propel the sector into the digital age. If AI/ML is to become a priority for oil and gas companies in Canada, a tight link to the sector's strategic imperatives could surely help accelerate adoption.

Which of the following technologies is your company currently implementing?



Which of the following technologies do you expect to have the greatest positive impact on your business over the coming five years?





Drivers and critical questions for AI/ML need to be anchored on the business strategy

Success in terms of the deployment of AI/ML in the context of the oil and gas sector is predicated on a few important strategic drivers and critical questions, which create the backdrop for any new initiatives.



Costs

There should be a business case – a “why” and a link to the bottom-line impact. Otherwise, AI/ML won't be successful. Given the pressure the Canadian oil and gas sector is under, cost and therefore efficiency need to be the driving forces for the strategic success of such transformative change programs.

- ▶ How does the application of AI/ML integrate into the overall business strategy of operational excellence and cost reduction?
- ▶ What's the cost-related business case for change in applying AI/ML?
- ▶ What level of cost reduction is required, and where in the business do the opportunities lie?



Quality

AI/ML needs to be positioned as a tool that enables businesses to make more quality-based decisions that drive deeper insights and value.

- ▶ Do you know what problem you're trying to solve?
- ▶ Do AI/ML tools exist in the business today, and are they being applied successfully to ensure more quality outcomes?
- ▶ Are you willing to invest time and effort into finding the right tool that drives better and more quality-based decisions?
- ▶ Has AI/ML been positioned in the business as a new tool that can be leveraged to drive quality?



Capabilities

To drive adoption and uptake in a sector concerned about the organizational impacts, the AI/ML strategy needs to harness the power of humans and machines working together in more collectively intelligent ways in support of scaling and creating new capabilities. There are activities that humans do extremely well and activities that the machines do better. The complementary skills and capabilities of both should be harnessed as part of a cultural shift in how work gets done.

- ▶ What activities do humans in the organization do well and not so well?
- ▶ Are there opportunities for humans and machines to work together in new and different ways?
- ▶ Are people willing to trust the technology tools to help make better decisions and add value?
- ▶ What new business capabilities is the organization missing that it wishes it had?



Harnessing AI is not optional for those that want to be, or continue to be, leading organizations. AI is here to stay and, when combined with Quantum computing, will, in the blink of an eye, revolutionize our lives."

Paul Selway
Vice President and Chief Information Officer, AltaGas Ltd.



Speed

Oil and gas organizations today capture vast amounts of data that teams don't always know how to use or process rapidly enough without involving hundreds of people. For AI/ML to be successful in the sector, it needs to help organizations use that data in ways it has never been used before – processing vast volumes quickly, drawing correlations, learning and ultimately helping make better predictions that drive costs down.

- ▶ Does the business capture data today that can be leveraged in an AI/ML context?
- ▶ Is the data captured today accurate and quickly accessible?
- ▶ Are there opportunities to process and learn from data more quickly?

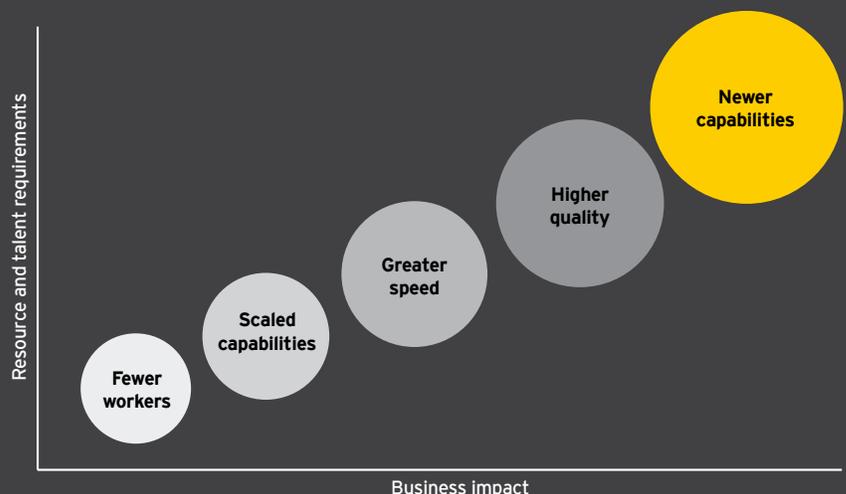
On the basis of recent EY research on the future of work, we studied nearly 2,000 occupations in four economies – the US, the UK, Canada and Australia. Those occupations were categorized into 15 business functions and 50 subfunctions across 16 industry sectors. This detailed mapping allowed the EY team to understand how applicable automation was to different economies, sectors and business functions.

One of the findings from this research was that automation has five areas of impact – fewer workers, scaled capabilities, greater speed, higher quality and newer capabilities. Leaders need to prioritize which area will best support achievement of the business strategy.

For example, if lowering the cost of production is an imperative, fewer laborers or greater quality may be the goal of automation initiatives. Alternatively, if increasing the speed of R&D insights is central to the business strategy, greater speed or newer capabilities may be prioritized.

The organization's business strategy can indicate a strategic desire to explore and exploit AI/ML. But the rubber hits the road on how well leaders and employees can identify real-world problems that lend themselves to the use of the technology in a way that drives business results.

AI's five areas of impact





An oil and gas sector ripe for AI/ML opportunity

A number of sectors have invested early and heavily in the AI/ML value proposition, but the oil and gas sector is lagging behind. The lack of progress in oil and gas means it's ripe with opportunity. The following, while not an exhaustive list, are just a few examples where AI/ML could be applied immediately to drive business value.



1

Human resources (hire to retire)

The oil and gas sector hires thousands of people every year during boom cycles, and therefore could benefit using AI/ML from a talent management perspective. There's the potential to develop AI/ML algorithms to help scan the many résumés received by HR, and look for clues in terms of candidates who might be worth proceeding to the next round. On the basis of examples from other organizations that use ML in this capacity, the predictions strongly correlate with the real-world results in terms of hiring.

Goldman Sachs, for example, has developed its own tool to analyze résumés with the intent of matching candidates with the division that best fits their experience

and career interests. A step further might be how to apply AI/ML from a "language" perspective, whereby first-round interviews beyond the initial résumé screening could be executed by machines, with both having the potential to save the sector time and money in terms of recruiter headcount. HR teams could potentially be redeployed to more strategic HR functions, such as people strategy, workforce planning and organizational effectiveness.

AI/ML could also be applied to workforce management and talent acquisition. Examples include predicting at-risk high-value employees or talent shortages, and capturing institutional knowledge of seasoned workers who are close to retirement.



2

Finance (cost allocations)

In the oil and gas sector, complex accounting is typically very involved, with armies of highly qualified accountants moving funds around through cost accounting and cost allocation processes. In fact, EY uses AI to automate some of the tasks its accountants perform, such as examining cash flow and expenses. These activities are cumbersome and time consuming, and the result of highly customized ERP systems, and business units and functions that are unwilling to go with standard ERP, and of leaders needing

to see data and reports in a certain way. Cost allocations are very rules based, and are, therefore, ripe for AI/ML tools that could be programmed and taught to learn how to do the cost allocations, potentially helping redeploy specialized accountants to more value-added analysis, insights and more informed decisions.



Maintenance (truck engine maintenance planning and execution)

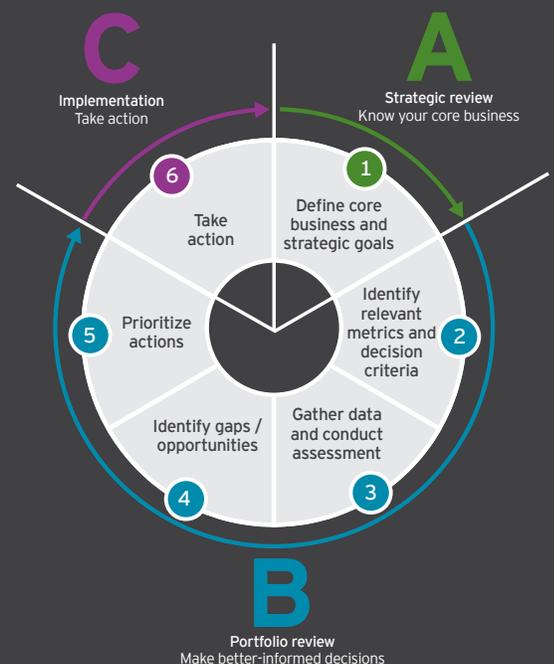
Equipment such as truck engines used in the oil sands sector capture vast amounts of data in terms of vibration, temperature, pressure and throughput, but most of that data never gets used. Companies spend thousands on the purchase and maintenance of these engines. Coming up with ways to better sense and predict engine failure before it happens could potentially reduce more problematic and expensive maintenance issues, and increase the trucks' uptime. Capturing the data from the engines in some kind of "data lake," using AI/ML to help find correlations and incorporating learning could drive more predictive insights to drive better performance of the engines, reduce costs and implement more

cost-efficient preventative maintenance programs. As an example, Tesla, Inc. has integrated a telematics system by which it collects targeted information from the engine and processes that data through ML to provide predictive maintenance information directly to the client. The client is therefore warned of a failure before it happens and is given a recommendation for next steps to address the problem. Similarly, General Electric subsidiary GE Digital has developed an ML tool called Predix that does predictive maintenance on industrial equipment used in the oil and gas industry.



Capital planning (portfolio management)

We've seen a huge amount of consolidation in the sector as a consequence of oil prices, with larger companies with strong balance sheets acquiring the assets and entire companies from smaller, in-distress organizations. Executives are constantly evaluating their portfolios, trying to make high-stakes decisions on what to buy and what to sell. AI/ML could help executives assess the historical performance of targets, evaluate key metrics, identify gaps and opportunities, and make recommendations on buy or sell decisions, thus influencing various aspects of the portfolio management process. The financial institution Blackrock, Inc. is applying AI/ML techniques to consistently meet its clients' investment goals by delivering alpha, reducing return volatility, and bringing generic value to their portfolios.





5

Subsurface (well data analysis)

Oil and gas companies employ skilled geologists, petrophysicists and geophysicists who analyze complex geological rock formations and well data. To assess where the hydrocarbons can be found and assess specific volumes (potential, probable and possible), these professionals use complex modeling techniques and software. AI/ML, working in tandem with humans, might be able to process the data in more efficient ways,

find correlations and develop better recommendations on whether to explore and develop further or walk away, either saving or creating investment value. MinePortal by DataCloud is a cloud-based AI platform that does exactly this by analyzing geosciences data by integrating exploration and production (E&P) drill data, block models and control measures into one platform.



6

Environment, health and safety (safety assessments and root cause analysis)

Owing to the nature of the sector's operations, safety is a primary concern, both offshore involving platforms and the transportation of people via helicopters, and onshore where heavy equipment, toxic gases and other hazardous environments exist. Oil and gas companies prioritize safety as critical to the success of day-to-day operations, and many have deployed safety management systems and behavior-driven activities, and embedded safety leadership in the operating business units. While immense data is captured on why safety issues occur, what

happened, the root causes and investigations to try and prevent future incidents, they still happen. AI/ML or deep learning has the potential to assess this data and learn from it over time to drive deeper insights into root causes, thus informing different and perhaps better preventative decision-making. For example, NASA has been using AI principles to create algorithms that analyze data from the aviation industry with the intent of finding issues before they become incidents.



7

Inventory management (material replenishment planning and optimization)

To keep assets running smoothly, one of the requirements of running large and complex assets in a capital-intensive industry is maintenance of spare parts. The sector has historically operated a network of large warehouses across the country, storing materials and equipment on hand for maintenance needs, all managed through an ERP system. Apart from the use of robotics to automate warehouse picking and packing processes, AI/ML has the potential to strategically predict demand, making stocking types and levels a source of value. IBM's Watson, for example, uses predictive weather analytics to provide accurate weather forecast information to companies

seeking to better predict demand on retail items. By using mathematics and predictive analytics, machines can assess historical consumption data, draw correlations and then make recommendations to human warehousing staff, or integrate directly into the ERP system, to help optimize stocking levels, replenishment and network planning between warehouses. These advancements could help reduce working capital and ensure customers' needs are more efficiently sourced and available.

These examples of business processes are simply illustrative and only scratch the surface. But they demonstrate the potential broad application of AI/ML in the sector. Understanding and prioritizing which processes have the biggest AI transformational impact is an important first step in any company's AI journey.

What is NLP?

NLP is a separate branch of AI from ML and robotics. The majority of knowledge and information is recorded in documents, and NLP has the ability to extract information, translate, search for information, generate text and perform sentiment analysis. NLP takes inputs, translates those inputs to vectors and eventually produces a set of outputs that can add value.

Can NLP be applied to oil and gas?

There are numerous applications of NLP to the oil and gas context, including basic translation services from English to French, which is important in some aspects of doing business in Canada, as well as first-line IT support using chatbots, personal assistant support for leaders using AI assistants to book meetings and schedule appointments. In the US, 10 billion meetings are set up every year; for example, x.ai, a New York City-based AI startup, provides a virtual personal assistant for scheduling appointments over email and managing calendars. NLP can also be effective for communications support related to monitoring sentiment in the public domain, including news reports and summarizing analysis of large volumes of data quickly to understand what stakeholders are thinking. It can also be effective in supporting tax knowledge workers in completing corporate tax filings by taking on the more basic repeatable tasks, thus allowing humans to focus on more complex issues.



AI has the potential to help transform how the oil and gas sector leverages data like never before. We're on the cusp of some exciting opportunities to drive new insights in support of business performance."

Sandy Martin
Senior Vice President, Digital, and Enterprise Technical, Suncor Energy

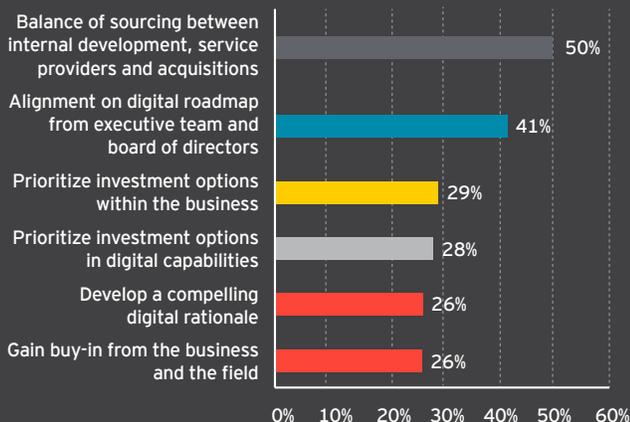


Top 10 critical success factors

The EY survey of the super majors also identified the major challenges related to the implementation of new technologies such as AI/ML. The EY team found that more than 50% of companies said that the balance of sourcing between internal development, service providers and acquisitions was their number-one challenge. With rapid and ongoing technological advancements, it's often hard to keep up and know what to build vs. buy.

When thinking about the deployment of AI/ML in the context of the oil and gas sector, it's not only about knowing the potential business processes where AI/ML can be applied, but also understanding how broader considerations related to leadership, strategy, roles and responsibilities, data, platforms, governance and capabilities all play a role in successful adoption within the organization.

What is the greatest strategic challenge your company faces in adopting new digital technologies?



1. Leadership engagement

Buy-in and support is required at the C-suite level. AI/ML requires a fundamental shift in how work gets done and how decisions are made. So support right from the top is required to get sponsorship, ensure the right investment and drive the transformation. AI/ML projects require ongoing effort to build and refine models to help the tools learn, so a long-term approach with leadership buy-in is essential. Leaders at the top don't need to understand the technology, but they do need to support the organization's experimentation and the business cases for AI/ML.

2. Strategic integration

Any AI/ML activity that might be planned as part of a long-term focus and effort, including aspects of cost reduction, needs to be tightly integrated into the business strategy. In addition, AI/ML activity should be integrated into the digital/IT strategy as well as workforce strategy in terms of the role those functions play in enabling the business to solve AI/ML problems.

3. Long-term thinking

This is not a one-and-done program, but an ongoing capability that needs to be developed in the organization, either through insourcing or outsourcing as part of a digital ecosystem. Oil and gas companies that want to drive value in AI/ML deployment need to consider the multiple horizons, and appreciate the ongoing effort and patience required to be successful. There is no silver bullet to make AI/ML work; it takes work, effort, design, collaboration with partners, refinement of models and testing. Many early projects will have a low return on investment and a limited impact – they primarily provide learning opportunities, but that learning is essential and the first step on a transformational journey.

4. Problem definition and types

The problem needs to be simplified into binary decisions; the amount of binary decisions can grow over time and the AI/ML can pick the right path for every binary decision. Businesses need to get this right and they also need to pick a problem that is an AI/ML problem (where to play). Often, companies pick problems that teams don't know how to solve, so while they think that AI/ML can solve it, it's not always necessarily the best solution.

5. Phased approach

Thinking about the business approach to AI/ML in a structured and methodical way is crucial. EY recommends:

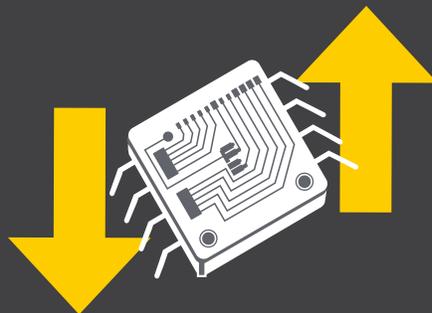
- ▶ Defining the business problem you're trying to solve
- ▶ Collecting the data (e.g., through sensors), which in many cases many companies already do
- ▶ Prediction part, which looks for the correlations
- ▶ Understanding why something happened the way it did, which is also about machine and human working together

The approach also needs to be human centered – to help the program learn, it's important that humans help guide the machines and set up the optimization properly to support this.

Putting AI to work Top-down or bottom-up? Both!

Top-down

- ▶ Identify a business problem with an "intelligence gap"
- ▶ Measure the value of a perfect solution
- ▶ Determine "how good is good enough" to get the most value
- ▶ Access technical feasibility



Bottom-up

- ▶ Identify an AI technology
- ▶ Look for business problems to solve
- ▶ Measure the value a solution might deliver
- ▶ Experiment to determine what value can be provided

6. Organizational capabilities

It seems obvious that in order to deploy AI/ML, you'll need human skills in programming, mathematics and deep IT skills in areas such as architecture to help design and deploy the tools. But perhaps what's less clear is the need for someone to interpret the tests (human and machine working together), doing a diagnosis that would never have been possible before. In addition, the role that engineers can play as a translators to the quants, who are doing the deep analysis and building models, is critical to success. Humans need to step in when the machine fails, which is the opportunity for the machine to learn from the human. At an enterprise level, it's also important to assess strategically what capabilities you build within the organization and what capabilities you outsource to third parties, and to consider how the workforce needs to transform the way it works in the future. Think about your capabilities as part of a broader business ecosystem comprising the organization, partners, academe and your competitors, since some of the skills needed here are so specialized that it will be difficult to find people to hire and then keep them busy.

7. Foundational data

The oil and gas sector is flush with data, but getting the data right, cleaned and accessible upfront is critical. Also, being able to have the processing power that can handle the volumes of data to feed to the machine is a potential gap. The data the machine gets needs to be unbiased. If you only give the data on good projects or outcomes, the machine only bases its learning on those good projects, which limits the machine's ability to learn. The data needs to be well rounded, otherwise the outputs and recommendations might not be what people expect; biased data gives biased views. Bias in AI/ML is potentially a problem – if there's bias in your data, AI/ML will amplify it unless you specifically put in checks to prevent that from happening. AI/ML systems also make decisions more quickly, so businesses must develop appropriate risk monitoring and management approaches. Once the data is in good shape, it creates a fantastic foundation, and as AI techniques get better and evolve, they can easily be applied to the data, and business benefits can be achieved.

AI talent

According to a recent EY survey, 56% of respondents saw a lack of AI talent as their greatest barrier, a sizable jump from the 36% reported just four months earlier, when we posed the same question to a separate group of technology professionals. The sector is doubling in size each year, but it's still very small, given the expectations. This leads to a significant risk of the Dunning-Kruger effect – people believing they know much more than they do – and the risk of overpromising.

8. Platform selection

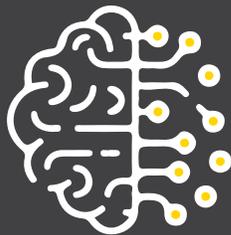
AI/ML involves large amounts of mathematics (statistical formulas) on top of decision trees. The statistical formula is different based on whatever problem you're solving. The technology platforms need to support the calculations (different platforms use different mathematics) and support a continuous AI learning loop. It's also important to decide whether the platform is for a proof of concept or long-term use. The world of AI/ML is so new that the platform might not exist next year, so it's critical to write down your code so that you can use it on another platform in the future.

9. Technology differences

It's important to make sure you understand the difference between ML, which is based on algorithms that can learn from data, and more traditional rules-based programming, including robotic process automation. Both play a role in business, so it's critical to be clear about the differences and when and how to apply them in the business.

10. Overcome the fear factor

The media tends to focus on the fears associated with AI/ML rather than the benefits – consequently, leaders at large enterprises may spend more bandwidth addressing those fears than exploring the opportunities. The AI/ML community needs to take ownership of this issue and drive conversations that allow business leaders to address and move past some legitimate concerns. AI is simply a continuum of the technology evolution, so we need to understand and adopt it, and at the same time study general intelligence, to ensure we protect humans and develop the technology in a responsible and ethical way.





Conclusion

The AI revolution is already here for some, and for others, such as oil and gas, it's just around the corner. AI and ML techniques applied to the sector have the potential to take large amounts of structured and unstructured data with a processing power far greater than a company's workforce, creating transformative impact. What's more, when AI and ML are coupled with human workforce capabilities, the combined collective intelligence impact has the potential to create lasting competitive advantage.

Given the constraints the oil and gas sector faces – social license challenges, ongoing pipeline issues that impact access to market and price differentials – a strategy based on reducing costs, increasing speed and quality of decisions, and building new capabilities that scale is going to be the difference between surviving and thriving.

Labor-intensive and manual activities that involve large amounts of data are great candidates for AI, ML and NLP solutions. These tools have the potential to help the sector find ways to augment the existing workforce, driving better and faster decision-making, leveraging the huge amounts of data and analysis that is required to explore, exploit and operate oil and gas wells and facilities in game-changing ways.

The challenge for the C-suite in the sector will be to find approaches to quickly realign businesses to fully leverage AI technologies. Building the organizational infrastructure and models to enable AI/ML to work takes leadership, long-term effort, a willingness to fail, and deep skills and capabilities to rethink how we're doing everything. Leaders today have the opportunity to stay ahead of their competitors by adopting a rigorous approach for identifying and prioritizing AI-related projects that build distinctive market advantages, and deliver value for their businesses. The potential prize, if managed carefully and responsibly, is limitless.

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