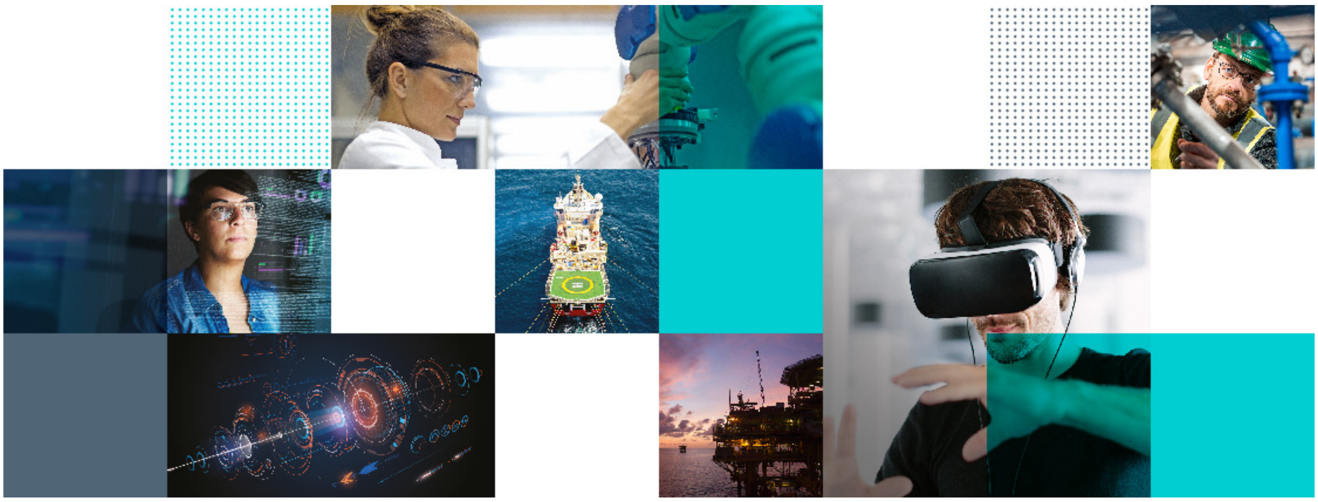
The Oil & Gas Technology Centre
Your Innovation Partner

Application of data analytics technologies to improve asset operations and maintenance

Digital landscaping study of the oil and gas sector

Consolidated findings and recommendations



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Foreword

Facilities management is an area of huge importance for the sustainability of the UKCS. The recent OGA publication UKCS Production Efficiency in 2017 shows the great progress that the industry has made and continues to make. It also highlights the substantial prize that remains to be captured.

The Technology Leadership Board (TLB) and the Oil & Gas Technology Centre have completed this industry study which shows the positive impact that data analytics can have in supporting the next ‘step change’ in asset reliability and maintenance performance. Those operators that have deployed data analytics have benefited from operational and cost efficiencies, with the technology demonstrating some of the opportunities that a more widespread industry deployment can realise.

There are many learning opportunities for the industry to capitalise on. From within the oil and gas sector there are tangible benefits for operators to share knowledge and experience, allowing for more effective and timely technology deployments. Furthermore, residing in other industry sectors there is further knowledge that the oil and gas sector can look and learn from.

The TLB has an important part to play through the communication of the content of this report to the wider industry, creating clearer sight of the opportunity for the industry leadership and garnering support for a more extensive exploitation of these digital technologies. We look forward to working with the Technology Centre on the broader digital transformation agenda for the UKCS oil and gas industry.

We are very grateful to all the organisations which have participated in this study, including operators, vendors and representatives from other industries, together with the MER UK Asset Stewardship Task Force (ASTF) and the Production Efficiency Task Force (PETF). We are particularly grateful to the Technology Centre (and previously the ITF team) for funding and managing the study, and to OPEX Group for providing their technical knowledge for the analysis.

Carlo Procaccini

Head of Technology, Oil and Gas Authority
Co-chair, MER UK Technology Leadership Board

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1. Executive summary

This report was commissioned to understand the level of adoption around digital technologies in the oil and gas industry and identity the barriers to adoption. The average production efficiency across the sector is currently 74% with a limited approach to the application of digital technologies. In order to dramatically change this level of efficiency, gain reduced maintenance costs and as a result extend asset life the industry needs to fully embrace effective use of digital technology.

Improved production and efficiencies as a result of appropriate use of digital technologies and focused data analytics may contribute significantly to maximising economic recovery of the UKCS hydrocarbon resources (MER UK). The size of the prize is estimated to be in excess of $2 billion annually across the basin (Section 4).

The study engaged with multiple stakeholders both in the oil and gas industry and other industries and provides a number of case studies to illustrate both the potential value and the current gap in application of available digital technologies. The study has also developed an easy to use tool to allow all operators to evaluate the level of their digital analytics technology maturity to enable them to identify gaps and develop a plan to address areas of opportunity.

The study found the that oil and gas installations have more than adequate sensor coverage and more than 60% of the industry reported good to excellent transmission and data storage capabilities. However, the industry is lagging behind other industries in the exploitation of the data. There appears to be a lack of awareness in the industry around what digital technology is available and more importantly what it can deliver to their business. This is compounded by a perceived high cost of implementation and risk aversion which acts as a barrier to the deployment of existing and/or new digital technologies.

However, a number of Operators within both the local and international oil and gas industry have already started using data analytics technologies and as exemplars, they have demonstrated that tangible value can be realised through successful deployments. This value has been delivered through avoidance of lost production, increased production optimisation and reduced lifting costs, including maintenance. The study captures some of their case studies and a number of examples from other industries.

The report also outlines a number of recommendations to overcome the identified barriers to assist the oil and gas industry unlock this opportunity, including:

1) Leverage an industry forum to create an open environment to share the developed case studies in this report and discuss how digital technologies could deliver value to UKCS operations.

2) The OGA to engage operators on the opportunity to deploy digital technologies on their UKCS assets as part of their upcoming technology plans.

3) Issue the industry with a standard methodology for assessing their data analytics technology maturity.

2. Introduction

2.1. Background

In 2017, production efficiency (PE) defined as actual production as a percentage of economic maximum production potential across the UKCS averaged 74%, with resulting losses of 200 million boe (barrels of oil equivalent) with approximately 55% of all losses as a result of plant loss. (Ref: UKCS Production Efficiency in 2017, Oil and Gas Authority).

The challenge for the industry is to improve its production efficiency and to minimise those lost barrels. One of the main focus areas that could potentially help achieve these targets is through the use of digital technology.

It is a commonly expressed view that the oil and gas industry has been slow to adopt digital technologies for improved understanding and productivity, and that other industries are far more advanced. In addition, there is a lack of clarity around the extent of the application of data science within the oil and gas sector, and specifically within the UKCS. By example, views on availability of data from ageing assets range from “too much” to “we cannot get the right data”.

This landscaping study investigates the current use of production and operations related data, the potential contribution it may make to sustainably improving production efficiency and how it may be used to reduce future unplanned production loss.

It reviews, assesses and evaluates:

- what is being done and what has been achieved in other industries;
- what is being done and has been done thus far within the oil and gas industry;
- examples of and value realised from success stories;
- where significant opportunities exist, and;
- what barriers may prevent the unlocking of these opportunities.

This report provides clear recommendations for industry action from representative industry and technology bodies such as Oil & Gas UK and the Oil & Gas Technology Centre.

2.2. Scope

The landscaping study focused on topsides equipment and associated systems. Subsurface, wells and subsea production facilities were all excluded from the study scope as these may be a subject of further investigation at a later date. Additionally, it was agreed that IT cyber security aspects resulting from the adoption of these technologies were not in scope.

2.3. The key stakeholders

The key stakeholders are the senior oil and gas industry leaders represented by the Technology Leadership Board (TLB), the Asset Stewardship Task Force (ASTF), The Production Efficiency Task Force (PETF) and the Oil and Gas Authority (OGA).

2.4. Governance and organisation

The study was commissioned by the TLB on behalf of the industry and was sponsored by the OGA. It was managed by the Industry Technology Facilitator (ITF) and the Technology Centre and was technically supported by Operational Excellence Group Ltd (OPEX). The steering committee had representatives from the TLB, OGA and Technology Centre, as well as from the ASTF and PETF.

2.5. Methodology

The following methodology was used:

- Enrolment and engagement with the key stakeholders, oil &and gas operator and key supplier community;
- Efficient data gathering through a structured, online questionnaire;
- Focused interviews with a number of UKCS operating companies and a sample of companies outside the UK oil and gas industry;
- Focused interviews with a number of data analytics technology product and service providers;
- A workshop with key stakeholders;
- Drafting a report for review in accordance with the scope and deliverables;
- Delivery of the final report.

3. Oil and gas industry landscape

3.1. Data analytics technologies

The UKCS has a diverse portfolio of assets, hubs and infrastructure often with a mixed heritage of ownership and consequently different technology platforms. Hence, a “one size fits all” approach, aimed at supporting digital initiatives to drive Production Efficiency (PE) is not appropriate, particularly when considering aged and mature assets with those brought onstream in the past few years.

As referenced in the appendices the study is intended to quantify the extent to which data analytics technologies are being applied across the basin. It also seeks to quantify the extent of the commonly expressed view of “data poor assets”, identifying data transmission and storage barriers preventing the use of this data in ultimately supporting decision making.

Rapid advances in technology, with increasing sophistication of available solutions in sensor, transmission, and storage technologies combined with the ability to process and analyse data rapidly, enhance agility and support right time decision making.

It may be reasonably concluded that these rapid advances in technology, spanning the whole spectrum of digitisation, have led to widespread confusion and uncertainty as to which technology platforms can be adopted to meet specific asset needs.

In terms of data acquisition, transmission and storage, the study concluded that, in general there were no major issues in acquiring the operational data within the asset with emergent sensor technologies appearing to improve this situation.

Additionally, there were very few assets with “stranded data”, a consequence of improved transmission capabilities with widespread fibre optic and 4G technologies. However due to bandwidth limitations, some operators had adopted prioritisation protocols to limit social use.

Without exception, all study respondents had storage capacity in the form of data historians with data density and capacity at individual operator preference. Operational data being predominantly used for visualisation and descriptive purposes i.e. analysis.

The following chart (Figure 3.1) identifies the extent and maturity of data analytics, the perceived value level and typical focus areas. Distinction is drawn between the various technologies in the attempt to reduce confusion that currently exists and which may be a barrier to wider adoption.

Value level	Definition	Techniques	Predictive capability of the technologies	Typical focus areas	Typical outputs
5	Optimisation	Prescriptive (Level 4) supplemented with artificial intelligence & machine learning	High [with greater efficiency]	Process System & Equipment Degradation	Identification of emerging anomalies with contextualised threats & recommendations
4	Prescriptive	Applied data science combined with domain expertise	High	Process System & Equipment Degradation	Identification of emerging anomalies with contextualised threats & recommendations
3	Predictive	Packaged analytics (configured monitoring software – forward projections of previous known events)	Limited	Equipment Degradation	Alerts based on previous known or pre-configured events
2	Rule Based	Condition Monitoring	Low	Equipment Degradation	Alarms / warnings based on OEM / engineering rules & assumptions
1	Descriptive	Dashboards	None	Trends & Patterns, retrospective analysis or onshore monitoring of multiple data sources	Reporting & Visualisation

Figure 3.1 Data analytics technologies by value levels

3.2. Oil and gas industry case studies

Summary

During the course of the study, a number of examples were identified from the oil and gas industry where the use of data analytics technologies was being deployed to directly identify potential failures in sufficient time to allow for timely intervention and the avoidance of expensive outages and maintenance costs.

There were no examples of a widespread deployment of data analytics technologies at a company level, however there are some prominent examples that demonstrate value including a 65% reduction in system outages and maintenance savings in excess of £1m per year on a single system. Each case showed how either increased production was achieved and/or lower maintenance costs. Both of these benefits contribute to the potential for extending asset life.

These cases are summarised in the following Figure 3.2 with an estimate of the value level being used.

	Case Study	Technology	Benefit	Value Level
1	Nexen,Buzzard asset – Opex Analytical insights for a full process gas compression system	Predictive analytics to detect warning signs and identify emergent system failures	$20m of production revenue safeguarded	4
2	Upstream Oil and Gas Asset - GE Asset performance management system deployed on a water injection system	Accessed disparate data sources and used analytics to create actionable insights	$60k in production lost cases avoided	3
3	National Oil Company – Arundo Creation of a machine learning model to predict logistics needs	Use of analytics to analyse operational variables and build predictive model	Increase in equipment use by 22% and associated NPT reduced by 15%	4
4	North Sea Operator Address a bottleneck in the production system	Analytics used to forecast the probability of oil in water incidents	Production increase of 0.25-0.5%	3
5	UK Operator – Opex Analytics approach to a new start -up gas compression system	Prescriptive Analytics approach to identify emergent abnormal process system behaviour	Contributed to $3/bbl lifting cost reduction	4
6	Marathon Oil – OSI Reduction in days to drill a well	Use of real time data analytics to develop an optimised drilling package	1 day reduction in time for drilling well and reduction in downhole tool damage	3
7	Santos onshore assets – IBM Maximise production uptime	Using analytics package on structured and unstructured data to optimise maintenance scheduling	$10m AUD in savings by increasing production uptime	4
8	BP North Sea Assets Application of System 1 & Smart Signal in enhanced condition monitoring	Using packaged analytics in identification of abnormal machinery behaviour	80,000 boe of production deferral avoided	3

	Case Study	Technology	Benefit	Value Level
9	Chevron North Sea Assets Application of Advanced Condition Monitoring	Using online monitoring to obtain real time information on machinery condition	Expedient diagnosis of abnormalities resulting in improved running time and avoidance of production loss	2

Figure 3.2 Summary of Oil and Gas Sector Case Studies. Note, case studies highlighted in turquoise are exemplars

3.3. Case studies

NEXEN DEPLOYS PREDICTIVE ANALYSIS TECHNOLOGY SERVICE

OBJECTIVES

Explore new technologies that make use of existing operational data sources to provide analytical insights.

Enable decisions and interventions to maximise production uptime, enhance business performance and mitigate risk.

APPROACH

Nexen engaged OPEX Group to apply a predictive analysis service on the Buzzard platform to detect warning signs and identify emergent system failures, prior to the event occurring.

The scope covered the full process gas compression system, including separators, coolers, exchangers, gas compressors, drivers, valves & instrumentation.

IMPACT

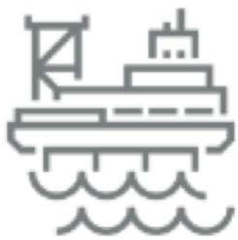
Reduced maintenance costs and the high cost of unplanned equipment repairs.

A reduction in system failures and downtime.

Highlighted rapidly escalating problems and longer term threats at a very early stage.

Identification of performance improvement opportunities.

$20million of production revenue safeguarded in 2016.



SOURCE: Published Case Study. Oil & Gas UK Efficiency Hub Portal.

GE ASSET PERFORMANCE MANAGEMENT SOLUTION DEPLOYED ON WATER INJECTION SYSTEM

OBJECTIVES

GE's Digital Asset Performance Management solution (Predix) enables optimal asset reliability, availability and performance.

The suite connects disparate data sources and uses advanced analytics to turn data into actionable insights.

APPROACH

Predix was deployed on a water injection system of a customer's Upstream Oil & Gas asset where it detected a deviation in the pump performance.

Specifically, Predix identified increased vibrations on both drive and non-drive end of the pump since the previous pump operation.

The anomaly was captured in a weekly report for discussion with the customer.

After the alert the customer initially fixed an oil leak but vibrations increased on start up. Further analysis revealed a faulty gearbox.

IMPACT

Due to the early notification the customer was able to replace the gearbox.

As the pump was spared the customer was able to keep the machine offline to execute maintenance.

The single catch was estimated to have avoided over **$60k in production loss costs.**

SOURCE: Published Case Study. GE Email Newsletter.

LOGISTICS IMPROVEMENT WITH ARUNDO

OBJECTIVES

A National Oil Company had annual spend of $300m on offshore logistics. Supply chain decisions were reactive. Utilisation and inventory levels were sub-optimal. In one unit, in excess of 1400hrs of non-productive time was related to logistic delays.

Creation of a demand based logistics approach.

APPROACH

Arundo data scientists developed a machine learning model to predict logistics needs based on equipment operational data combined with forward plans.

Build predictive models utilising historical information to analyse operational variables. Create a data driven cost based option of spot market v long term charter, load balancing of fleet and intelligent routing.

IMPACT

Predictive solution **built within 120 days.**

Increase in equipment utilisation of **22%.**

Model accuracy realises non productive time **decrease of 15%.**

SOURCE: Published Case Study. Arundo website.

NORTH-SEA OPERATOR PILOTS ADVANCED ANALYTICS ON MATURE, SEMI-SUBMERSIBLE, PRODUCTION PLATFORM

OBJECTIVES

Explore whether analytics could help optimise production settings and raise production output.

APPROACH

A North Sea operator piloted advanced analytics on a mature, semi-submersible, production platform.

The team of data scientists used three years' worth of data collected from 5,000 sensors and controls, totalling hundreds of gigabytes. The team used a machine-learning algorithm to skim the data for correlations and causalities.

IMPACT

By predicting the probability of pressure build-ups and reducing the size of each pressure spike, the operator may gain **1-2 % in production.**

An algorithm was developed to address a major bottleneck created by high oil content in water. This problem was constraining production and consuming the energy of the production team on almost half of all operating days.

An algorithm was applied to analyse historical data to determine the probability of oil-in-water incidents. This resulted in a **production increase of 0.25-0.5%.**

SOURCE: Referenced Case Study. McKinsey & Company website.

OPEX GROUP APPLY PREDICTIVE ANALYSIS SERVICE FOR NEW UKCS PLATFORM

OBJECTIVES

Support efforts to reduce lifting costs.

Use data to inform decision making to avoid production losses and improve the performance of critical oil and gas plant.

Avoid reactive maintenance costs.

APPROACH

OPEX Group were engaged by a UK operating company to apply their predictive analysis service to the gas compression system on a new asset.

The service makes use of predictive technologies, data science and oil and gas domain expertise to identify at the earliest opportunity the breakdown of system-wide relationships, which would not be transparent through conventional techniques.

IMPACT

OPEX claim a **saving of £400,000** in the first 6 months through the avoidance of reactive maintenance.

Accurately identifying, through a retrospective data driven analysis, the root cause of production losses and mitigation against future occurrence.

New facility, gas compression system reliability was improved through start-up, contributing to **>$3/bbl lifting cost reduction** through high levels of production.

SOURCE: OPEX Group submitted Case Study.

OSI WITH MARATHON OIL AND CONSORTIUM PARTNERS

OBJECTIVES

Drive to reduce the number of days to drill a well with onshore based modelling of remote operations.

APPROACH

With domain support engineers being remote from operations their ability to influence decisions was compromised.

They were connected to real time drilling data analytics and developed an optimised drilling package which was integrated with other visualisation and analytics suites and made available at the drill site.

IMPACT

$ savings in drilling equipment costs through reduction in downhole tool damage.

1 day reduction in drilling days per well.

$ well cost savings through optimisation of resources.

An increase in drilling penetration by **40%.**

SOURCE: Published Case Study. OSI presentation.

SANTOS – SAVING MILLIONS WITH A PREDICTIVE ASSET MONITORING AND ALERT SYSTEM

OBJECTIVES

To maximise production uptime and promote safe, efficient maintenance by using analytics technology to extract greater value from systems and data.

Provide right-time, actionable, effective information proactively, rather than in a reactive or look-back assessment.

APPROACH

Santos predictively models data from assets connected to the Internet of Things, providing early warning of equipment failure.

Using IBM's analytics software, Santos pulled structured and unstructured data from multiple sources.

IMPACT

Improved safety by cutting the time engineers spend in remote locations and travelling.

87% accuracy in predicting asset failure.

Optimised maintenance scheduling and use of materials. Significant reduction in cost of ROC batteries through deeper understanding of power usage.

AUD 10million+ in potential annual savings by increasing production uptime.

AUD 1.1million potential annual savings by using alerts to prompt inhibitor tank refills.

SOURCE: Published Case Study. IBM website.

BP APPLIES PACKAGED ANALYTICS IN CONDITION MONITORING

OBJECTIVES

Use enhanced condition monitoring techniques through the application of System 1 and Smart Signal in the detection of abnormal machinery conditions.

Use early warning signs provided by System1 and Smart Signal to facilitate efficient planning of remedial work.

APPROACH

BP deployed System1 and Smart Signal across a range of assets to support both real time monitoring of machinery performance along with long standing investigations into abnormal machinery condition.

Smart Signal was used to detect abnormal vibration and bearing temperatures on a Gas Turbine which indicated a problem with cooling medium.

IMPACT

Reduced maintenance costs and the high cost of unplanned equipment repairs.

A reduction in system failures and downtime.

The early warning provided by Smart Signal avoided potential production deferral of 60MBOE

Identification and understanding of machinery behaviour provided the BP team with confidence to re-start equipment 24 hours earlier than expected. This timely return to service contributed to avoidance of a potential 35MBOE production deferral.

SOURCE: BP North Sea.

CHEVRON ADVANCED ONLINE CONDITION MONITORING

OBJECTIVES

Developing essential information to evaluate the condition of the reciprocating compressors on a North Sea offshore platform.

Obtain real time information on the condition of the reciprocating machines. Facility for continuous trending and modelling allows for increasing uptime for operating machinery .

APPROACH

Chevron deploys System 1 online condition monitoring. Installed vibration measurement tools provide constant monitoring of vibration, pressures and rod positioning

Data is constantly analysed with hard and software and condition monitoring tools which provide detailed information of the machine condition to the machinery support centres.

IMPACT

The improved capability and understanding of the compressors allowed prompt and expedient diagnosis of abnormalities. This minimised threats to operations.

A reduction in system failures and downtime.

SOURCE: Chevron North Sea.

3.4. Data maturity model

The model has been developed by the analytics industry to help paint a picture of the maturity of data management within an organisation.

It forms a radar chart where each arm of the chart corresponds to an element of data maturity that helps to describe the overall status of how data analytics technology is used within the company. This model covers a number of elements that can be used to assess the maturity of the use of the data, the digital tools and techniques in managing production efficiency; namely

Data analytics capability – a measure of the extent of the analysis of the data captured from simple reporting through to optimising asset performance.

Breadth of data usage – a measure of how much and what data types are being captured.

Scope – a measure of the extent to which the tools are being applied across the assets facilities.

Timeliness – a measure as to what extent the information provides a historic understanding of asset performance through to information that can be used to optimise performance.

Operational integration – a measure of how embedded the process is within its normal working regimes.

Delivering value – a measure as to whether the use of the tools and techniques are adding value to the asset and how well that value can be assessed.

The advantage of this type of assessment is that it allows for organisations to focus on initiatives to improve the specific elements of data maturity that they consider adds most value to them. In addition, by creating a sector response it is possible to gauge not only the average position but also the spread and the exemplars. The fact that there are better performers should act as an incentive for others to at least investigate the potential of the technology further.

Based on a combination of the questionnaires and interviews, each of the assets was scored against this model and the aggregate of the UKCS and industry exemplars has been calculated.

The specific criteria can be seen in Figure 3.3, with the average data maturity of UKCS assets and the highest data maturity of oil and gas industry exemplars shown in Figure 3.4

The average score of the respondents provide a maturity score of between 2 and 3 for each element of the model as described in the following table:

The scores of the exemplars show a score in the range of 4 to 5.

Breadth of data usage	
5	Integrating unstructured data (inspection reports, imaging, etc.)
4	Integrating additional structured data (production, operations, environmental, etc.)
3	Current historian/sensor data
2	Historic historian/sensor data
1	Little or no regular use of data
Data Technologies & Methods	
5	Optimisation (prescriptive supplemented with AI and machine learning)
4	Prescriptive (applied data science combined with domain expertise)
3	Predictive (packaged analytics/ software - forward projections of previous known events)
2	Rule Based (condition monitoring with alarms)
1	Descriptive (queries, reporting, dashboards)
Timeliness	
5	Ahead of time (optimising approach to operations and maintenance)
4	Ahead of time (predicting the onset of faults and failures before alerts/alarms)
3	Realtime (interventions in response to alerts/alarms)
2	Ad hoc (interventions based on periodic inspections/readings)
1	No forewarning/anticipation of issues
Operational integration	
5	Automation of processes, including closed loop learning
4	Continuous insights, feed into engineers' daily work
3	Alerts passed to human decision makers
2	Selective reports feed human decision making
1	All analytical work offline, discrete from operations
Delivering value	
5	A proven core initiative in production and efficiency of related operations
4	Measurable improvements in production, business case to do more
3	Value hard to attribute due to human steps in decision process
2	Appreciation of potential value, no hard figures
1	No measurement, no appreciation of potential value
Scope	
5	Process system (equipment & process, operations, interdependency of connected systems)
4	Process system (equipment & process)
3	Equipment across system
2	Select Equipment
1	Aggregate view only, no consideration of individual machines

Figure 3.3: Data Maturity criteria and ranking

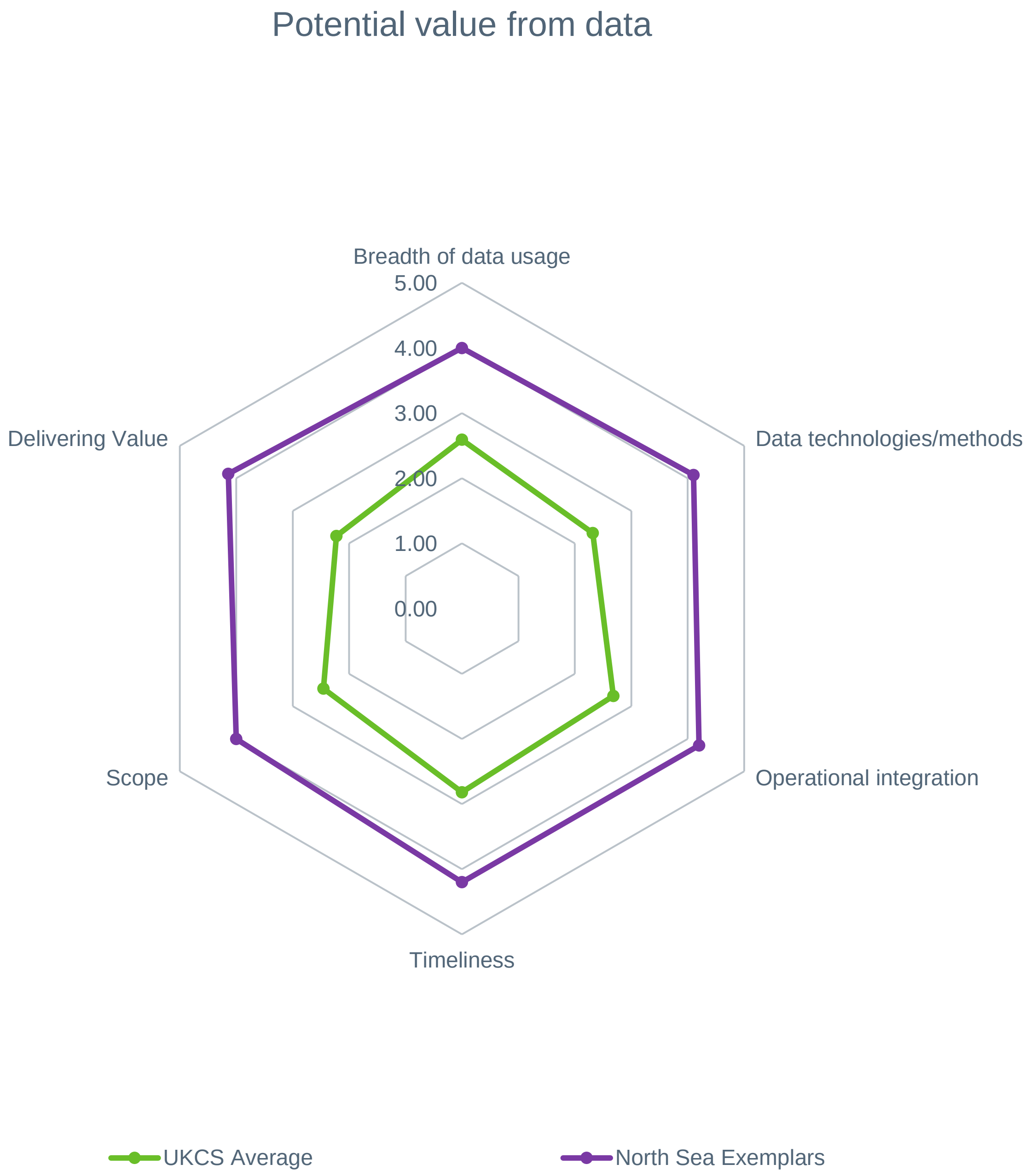


Figure 3.4: Average data maturity of the UKCS for all respondents (green line) and exemplar (purple line)

4. Potential gains from the adoption of data analytics technology

4.1. Status

The 2017 Production Efficiency Report issued by OGA concluded that efficiency had reached 74% with total recorded losses of 200 million boe. Plant losses accounted for 55% of this total representing 110 million boe (approx. $8 billion at todays' prices). The study questionnaire feedback from respondents highlighted a number of critical systems that were deemed to be the principle cause of loss within these metrics. These were:

- Gas compression
- Oil export
- Power systems
- Water injection

If the UKCS basin as a whole were to adopt the data analytics technologies deployed through the exemplar case studies (which have impacted on plant losses and operating costs), it is reasonable to conclude that the size of the prize in additional annual production revenue across the UKCS basin could be in excess of $2 billion per year.

This figure of $2bn is comprised of two components; 25% improvement in reliability of critical systems and associated increased volumes (evidenced through case studies) together with a 15-20% reduction in overall maintenance spend. A 1% improvement in PE in 2017, compared to 2016, across the basin delivered an additional 12 million boe.

The 2017 OGA report recognises techniques that use existing streams of data from platforms are already playing a part in improving efficiency. These techniques, such as predictive analytics, often adopted and adapted from other industries are already improving PE for some operators concluding that increased uptake could help drive UKCS efficiency higher in the future.

4.2. Opportunities

Opportunities for application for data analytics technologies identified during this study include:

1) Increase production efficiency and help to maximise economic recovery (MER) :
    a) Improve production performance / optimisation
    b) Prediction of failure / fault diagnosis (prevention is better and more cost effective than cure)
    c) Extending the life of field and UKCS basin as a whole
    d) Prediction / assessment of system health
    e) Prediction of production delivery
    f) To encourage further sharing and collaboration across the sector
2) Reducing operating costs, for example:

a) Reduce lifting costs

b) Reduce and optimise maintenance spend (planned and unplanned)

c) Assist the industry to shift from reactive to proactive

d) Reduce spare parts inventory and associated maintenance burden

e) Optimise logistics – weather, helicopters and planning

f) Optimise activity execution and workforce management

g) Improve asset support efficiency

h) Streamline work processes

i) Optimise annual shutdowns

3) Heath, safety & environment, for example:

a) Reduce levels of operational risk

b) Reduce the numbers of personnel offshore

c) Reduce the number of process safety related events

4) UKCS basin wide - growing data capabilities in this local region, for example:

a) Capitalise on the data and infrastructure that already exists

b) Further enhance the local economy

c) Encourage a growth of this area within the SME supply chain

d) Provide further export potential

e) Stimulate activity in other adjacent opportunities, e.g., asset integrity, well monitoring etc

4.3. The Oil & Gas Technology Centre

The Oil & Gas Technology Centre was established as part of the Aberdeen City Region Deal, with a goal to support the unlocking of the full potential of the UKCS, anchoring the supply chain in the North-East of Scotland and creating a culture of innovation to attract industry and academia to the region.

As highlighted by this report a number of the Operators within the local and international oil and gas industry have already started the journey towards more effective use of data analytics technologies and as exemplars, they have demonstrated that the potential value outlined above can be realised through more consistent deployments across the Industry.

However, some significant challenges exist, with confusion, misconceptions and a general misunderstanding of the opportunities presented by these technologies. This is compounded by a perceived high cost of implementation, a lack of understanding of just were to start and a generally risk adverse culture, which all acts as a barrier to the development of new technologies and the realisation of the potential benefit.

The Technology Centre works in partnership with the industry to de-risk and support development of new approaches and technologies and its Digital Transformation Solution Centre is currently working with industry to support and enable the adoption of new data analytics technologies that address the opportunities identified in this report.

5. Barriers to adoption of data analytics technology

Based upon the interviews, questionnaires and workshop the following areas were deemed to provide obstacles to the adoption and progression of data analytics technology.

Technical

1) The data and infrastructure are generally available on the assets, but the data is not being used to its full potential because there was a lack of knowledge about what further could be achieved.

2) Sensors / transmission/ hardware are considered to be generally suitable and in the right places to provide a data set for at least a basic analysis, although some respondents were unsure if the data was suitable and sufficient for data analytics technologies to be effective.

3) Transmission capability is largely in place and not seen as a barrier although issues and lack of clarity around the risks of data/cyber security were seen a potential barrier

4) There is no industry standard data platform or practices for the collection of and use of such data and therefore each operator would have to investigate and determine a solution individually.

5) Where a company did not have an agreed data platform / data architecture then it was perceived that this could constrain opportunities if the data analytics technology was introducing new systems to interface with existing asset systems.

6) There was considerable uncertainty about the development status of the data analytics technology and how proven it was within oil and gas operations.

Culture

1) Where an asset perceives that it already has a high PE with or without the use of data analytics technology or where PE is reported at Hub level then there is little motivation from Operators to consider doing anything more. In many cases spending less was cited as more important than achieving high PE.

2) Some respondents considered that they were already advanced in the used of digital technology and associated analytics and therefore there was little incentive to invest more time and effort in looking for other solutions.

3) As a leading indicator, several operators (45% of those surveyed) do not currently include the use of data analytics technologies as part of their OGA Asset Stewardship Technology Plans.

4) Lessons learned (both successful and otherwise) regarding production gains / losses are not consistently shared amongst operators or partners.

5) A number of respondents cited that supply chain barriers (IP / mistrust) restricts collaboration and sharing.

6) A commonly identified barrier was a reluctance to change, (in general terms), because there is no impetus to change the “firefighting” paradigm. Some respondents indicated that this may be related to protectiveness and a fear of job displacement.

7) A number of responses highlighted a risk averse culture, where solutions must be fully proven before acceptance within each company, (even though a solution may be proven elsewhere) combined with

a fear of being first, a fear of failure and a reluctance to be an earlier adopter. The norm appears to be that the technology needs to be fully developed, (or in many cases reinvented / customised) rather than rapidly adopt existing solutions on the basis of continual improvement.

8) A combination of reduced resources, lack of appropriate skills or knowledge and conflicting priorities tends to lead to potential initiative overload and leaves no time to consider fresh solutions, especially if it is perceived that they are relatively unknown, complex and will result in additional workload.

Commercial

1) There may be less incentive for the oil and gas industry to improve than in other industries, as margins are less tight than many other industries and the cost constraints in recent times due to lower margins have only reduced the willingness to invest.

2) In most cases respondents indicated there is more pressure and accountability around managing operating budget rather than investing in new initiatives / technology which have the potential to add barrels.

3) There is a perceived high capital cost of implementation and cost of service provision which creates an unwillingness to investigate, pursue or invest when combined with budget constraints and ageing / end of life assets.

4) In most cases there is no budget line for this type of solution so there are considerable internal efforts necessary to bring to fruition any trialling of these technologies. One or two respondents pointed out that without a budget there can be no trial, and with no trial there is no proof that the technologies are worth investing in.

5) Closely linked to the above, it was considered that a combination of uncertain costs and unproven benefits (within each individual operator) made it difficult, time consuming and a lot of work, to create a credible use case or business case that would allow the development or implementation of these technologies.

6) Proving the benefits, measuring success and defining payback, in terms of increased production (quantification) of applying data analytics technology can be hard to determine, as its unlikely that there will be a simple cause and effect relationship and more often than not it will be deployed alongside other improvement initiatives.

7) Within the responses one or two respondents stated that there was a lack of flexibility in commercial models from vendors to allow easy adoption.

Awareness

1) There is a widespread lack of awareness, knowledge and understanding amplified by extensive confusion created by the hype in this subject area.

2) Companies may be complacent, in that they think they are more advanced in the deployment of data analytics technologies than they actually are.

3) There is a lack of visibility of the opportunities that data analytics technologies present to the industry and a lack of clarity on the potential benefits.

4) There is a lack of belief in what may be possible or has already been achieved by others through the use of data analytics technologies.

5) There is limited opportunity to learn from others in the sector as there is no forum for knowledge and best practice sharing.

6) There is a belief that the technology is currently unproven, is simply hype and it is too early in the adoption cycle to be successful.

7) Uncertainty over the capability of the technology fuels a further belief that there could be large upfront costs with a lengthy implementation time needed to see any results (and probably not worthwhile).

8) There does not appear to be any industry standard solutions readily available.

9) Often seen as a one-off spend, not a journey of improvement, perhaps indicating a lack of appreciation that this space will continue to evolve and improve.

People

1) Ownership: Lack of clarity on who is responsible and accountable for data analytics technologies within the operating company. The ownership of a digital strategy or approach was typically unclear in an organisation and the dispersed responsibilities made having a unified approach difficult, adding further complexity to this barrier.

2) Accountability: Leaders who understand the problem statement typically do not have the accountability to facilitate a change. Conflicting accountabilities may also exist between duty holder and main contractor or FPSO owner / operator.

3) Resources: There was a strong feeling that there was little time to investigate and deploy technologies because operators have fewer resources following the downturn and what is possible is often limited by other priorities. Some respondents indicated that implementing data analytics technologies is too challenging for their company resources.

4) Leadership: It was highlighted that the buy in from leadership is essential to embracing the opportunity presented by data analytics technologies. However, it was cited by many respondents that this subject area was not seen as important or credible by senior managers.

5) Supply chain: No clear route or focal point within the operating company that the supply chain can approach to demonstrate the capabilities and benefits of data technologies.

6. Experience from other industries

6.1. Summary

Based on the case studies, obtained from other industry sectors and described in this section, there was clearly a breadth of data usage and data analytics which enhanced performance. The following points highlight some of the key findings:

Rail – using track data to set up a predictive analytics model for rail degradation which allowed Network Operators to predict failure and intervene in a timely manner to manage maintenance costs and avoid track disruption.

Renewables – developed a machine learning model to identify issues with the drive train on a wind turbine. The signatures from the data sensors identified a potential gearbox failure and by intervening this failure was avoided.

Nuclear – set up system to automatically interpret data from the graphite core and predict the condition of the fuel channels mitigating need for additional inspection.

Power Generation - using a predictive approach to increase the alarm time on turbines avoiding unplanned outages.

These cases are summarised in the following Figure 3.5.

	Case Study	Technology	Benefit
1	Renewables – Berkshire Hathaway Energy Analytics software applied to wind turbines	Machine learning anomaly model detection model identified potential gearbox main bearing failure	Increase of $3.3m of value per year
2	Aviation – IBM Use of predictive analytics on airplane engines	Data collected from each engine on each flight provided	Engine life extended and maintenance costs reduced by 20%
3	Power Generation -IBM Moving from advanced condition monitoring to predictive analytics in power generation	Use of predictive analytics to predict alarm time for turbine failure	Alarm time for turbine failure increased from 30 mins to 30 hrs and 20% savings from reduced outages
4	Nuclear - EDF Introduction of analytics for graphite core refuelling events in advanced cooled reactors	Use of predictive analytics to predict likely degradation and failure timescales in the fuel channels	Increased periods between inspections and reduction in unplanned outages
5	Railways – Network Rail Use of analytics to predict track failure	Using track data to predict potential failures of track and decide on repair or speed restrictions	Identified 70% of all emergent areas of speed restriction and reduced overall costs

Figure 3.5 Summary of other sector case studies

6.2. Case Studies

ANALYTICS SOFTWARE APPLIED TO THE RENEWABLES SECTOR

OBJECTIVES

- Harness data to generate more wind power and provide a clear view of business operations.
- Enable analytics-driven decision making.

APPROACH

- Uptake, a US-based analytics software company, partnered with Berkshire Hathaway Energy's subsidiaries to deploy a predictive analytics platform and products for the wind industry.
- A machine learning anomaly detection model was configured to find issues on the low speed side of the drive train.

IMPACT

- Uptake identified assets that were showing signatures of gearbox main bearing failure. A technician was sent to the tower and discovered the whole main bearing had shifted. The tower was shut down for resolution.
- Uptake claim $3.3M of potential value per year for an average large wind farm.

SOURCE: Published Case Study. Uptake website.

IBM CASE STUDIES IN AVIATION, RAIL AND POWER GENERATION

INDUSTRY	**AVIATION** working with aero-engine manufacturer.	**RAIL** working with major international rail operator.	**POWER GENERATION** working with an electricity generation company.
APPROACH	Data collected from each engine after each flight, basis of predictive models to give early warning of failures.	Moved from state-of-the-art reactive condition monitoring system to predictive approach.	Moved from advanced condition monitoring on turbines to predictive approach.
IMPACT	Engine life extended from 4-5 years to 6 years (overhaul costs between $3-10million per overhaul).	Disruption to the rail network was minimised.	Alarm lead time for turbine failure increased from **30 minutes to 30 hours.**
IMPACT	**>95% accuracy** in predicting various types of failure/incident 3 to 12 months ahead of time.	Predictive approach enabled advance planning, with rolling stock taken out of service without disruption for pre-emptive maintenance.	**20%** savings were realised from a reduction in outages and the cost of reinitiating power stations.
IMPACT	Maintenance costs reduced by **20%.**	**98% accuracy** in predicting severe alarms 7 days ahead of time.	Savings estimated at **$80,000** per turbine per year.

SOURCE: IBM submitted Case Study.

ANALYTICS USED FOR ASSET LIFE EXTENSION

OBJECTIVES

- EDF operate 7 Advanced Cooled Reactors in the UK. Collectively they generate 20% of UK electricity.
- With this aged infrastructure the key challenge is to achieve life extension of the reactor, plant and equipment through prediction of likely degradation and failure timescales.
- Reduce unplanned outages.
- Increase period between inspections (at £500k each).
- Optimise maintenance.
- Gain transparency indecision making and auditability.

APPROACH

- Use graphite core refuelling events rather than planned inspections as a source and capture of data. Develop fuel grab load trace.
- Automatically interpret data to predict condition of the fuel channels.
- Mitigate need for additional inspection.

IMPACT

- Continually used in support of risk based analysis.
- Improved understanding of core health through advanced data analysis supports lifetime extension.
- Continually used in support of risk based analysis .

SOURCE: Strathclyde University submitted Case Study.

A DIGITAL TRACK DECISION SUPPORT TOOL: NETWORK RAIL

OBJECTIVES

- Develop a digital Track Decision Support tool to overhaul the way Network Rail analyses track data leading to dramatic reductions in the volume of speed restrictions imposed.
- The need for speed.

APPROACH

- Development of a track speed restriction prediction set across manageable sections of track, providing accurate insights of emergent conditions of asset failure. Encompassing 20,000 miles of track and 23,000 switches and crossings.
- Rate of change of track geometry was graded to measure severity. “Super Red” worst case scenario all result in track speed restrictions or worse.
- The digital Track Decision Support tool established a rate of change in track geometry from train data acquisition.
- Degradation rates established allowing for prediction of failure and timely and planned intervention.

IMPACT

- In field evaluation the “Super Red” predictive capability accurately identified the location of **70%** of all emergent speed restrictions.
- Cost benefit analysis of reduced speed v cost of maintenance established, resulting in a reduction of overall costs.

SOURCE: Network Rail submitted Case Study.

SIEMENS CASE STUDIES IN RAIL, MARINE AND AUTOMOTIVE INDUSTRIES

INDUSTRY	**RAIL** Predictive Maintenance.	**MARINE** Remote Monitoring.	**AUTOMOTIVE** Improved Cycle Time.
APPROACH	Remote diagnosis facilitates predictive maintenance.	Remote monitoring facilitates expert centre support.	Digital production optimises plant design and facilitates manufacturing flexibility.
IMPACT	Increased availability and avoidance of unplanned downtimes.	Increased availability and avoidance of unplanned downtimes.	Enables shorter time to market.
	99.9% availability of trains.	Reduced cost for operation and commissioning.	3x more cars produced.
	Only 1 of 2,300 trips is late.	40% of all critical systems monitored in real-time with expert technical support.	30% less development time.

SOURCE: Published Case Studies. Siemens presentation at OGTC.

7. Conclusions and recommendations

7.1. Conclusions

Sector status

1) There is a clear imperative for the UKCS oil and gas industry to improve on the current levels of production performance.

2) There is a substantial opportunity for the industry to exploit data analytics technologies to unlock the full potential of the basin and significantly contribute to MER objectives.

3) The benefits of the use of a greater level of technology accrue from a combination of increased PE, reduced maintenance costs and asset life extension

4) The size of the prize is estimated to be worth in excess of $2 billion each year.

5) The industry is behind other industries in the exploitation of data analytics technologies. The data maturity tool provides a consistent methodology for establishing the status of the industry as it progresses in its use of digital technology.

6) The sector does not appear to be engaging fully with the supply chain to gain access to the latest technologies and contracting strategies which are being exploited in other industries.

Technology status

1) The data and infrastructure are generally available, but they are currently not being used to their full potential.

2) There is a variation across the sector in the usage of the technology

3) Some leading operators have already started to use data analytics technologies with demonstrable success and value creation. There are a number of exemplars who have successfully applied this technology both within the industry and in other sectors.

4) The industry has a lack of awareness, understanding and belief, accompanied by a number of misconceptions surrounding the potential opportunity that data analytics technologies presents.

Barriers

1) The key reasons behind the lack of industry progress include:

   a) There is a perceived high cost of implementation and service provision with long lead times, resulting in an unwillingness to investigate, pursue or invest.

   b) Due to the perceptions of prohibitive cost and unproven benefits, efforts are needed to create a credible internal business case to trial these technologies.

   c) There is a risk-averse culture accompanied by a fear of being first or failure.

   d) Many operators appear to be focussing on further reducing operational costs, with less attention on increasing production.

e) Proving the benefits, measuring success and defining payback (including quantification) is perceived to be very challenging.

f) A lack of specific data analytics skills together with conflicting and often reactive priorities, mean there is little capacity within organisations to focus on this area.

g) There is some evidence of learning from exemplars or others in the sector but overall there is limited sharing of knowledge and best practice.

h) There is a lack of clarity on who is responsible for data analytics technologies with many companies having no one with accountability for harnessing the opportunity.

7.2. Recommendations

Industry actions

1) Leverage an industry forum (such as, for instance, the PETF) to create an open environment to:

   a) Communicate the content of this study report to the industry

   b) Establish a common understanding of the opportunity across all levels

   c) Engage with the exemplars and solution providers to help dispel any confusion and misconceptions

   d) Enable learning from each other, share knowledge, success stories and facilitate closer collaboration with supply chain

   e) Facilitate an acceleration of the deployment of data analytics technologies across the industry (beyond pilots)

   f) Seek inspiration from other industries

   g) Encourage data science as a discipline at an equal level to other industry disciplines and liaise with universities about the industry need for data scientists.

   h) Consider publishing lessons learnt from sub-system failures with sufficient detail to enable cross asset learning where common lessons that can be learned.

2) The OGA to engage UKCS operators on plans to adopt (advanced) data analytics as part of their asset management technologies and methods

3) Issue the industry with a shared methodology for assessing the maturity of data analytics technology in use. This could include the data maturity benchmarking tool (radar chart) included in this report and could be used for a regular assessment across the sector in order to gauge the progress of with digital technology adoption, as well as benchmark with other sectors.

4) Issue information documents to industry, including on:

   a) Practical steps to progression (roadmaps)

   b) Technologies available and use cases

c) Assessing value and benefits (including quantification of value and ROI)

d) Change management and organisational aspects (including digital champions and skills)

Proposed supplementary studies

1) Carry out a study to evaluate the potential benefits of an open architecture, Industry Data Repository accessible by multiple 3rd parties to drive innovation and service provision.

2) Carry out a study to assess the value potential of bringing legacy operations online with wireless sensors or other emerging acquisition technologies.

3) Address data sharing and cyber security concerns at an industry level:

   a) establish digital security protocols.

   b) provide guidance on what data can be shared and how.

   c) establish a data sharing charter agreement inter/cross-industry.

4) Carry out a study to assess the potential value of using data from other sources (e.g. mobility, integrity etc.) to augment the reach of existing solutions.

8. Acknowledgements

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EDF Energy

Equinor

ExxonMobil

Intelligent Plant

Metis Labs

Nexen

NSMP Limited

OSISOFT

Petrotechnics

Repsol Sinopec Resources UK

Santos

Shell

Siemens

Spirit Energy

Step Change Global

University of Strathclyde

The Oil and Gas Authority

The Technology Leadership Board

Think Tank Maths

Total

Wood

9. Appendices

9.1. A1 output of questionnaires

A series of structured questionnaires were sent to participating companies and the aggregated responses are contained in the Appendix for the operator response and separately those from the vendors.

The main findings from the questionnaire are as follows:

Status

- **84%** of responders stated that they have a production loss management system and can identify loss by system. The common sources of failure are gas compression, power generation and water injection
- **55%** include their approach to data strategies as part of their OGA asset stewardship technology plan.
- **67%** of respondents state that they have implemented digital technologies on the main risk areas of their operation while one respondent felt that they were best in class already with data technology fully embedded into their business

Technical

- **90%** have part to good coverage from their sensors of the equipment they regard as critical
- **63%** have either good or excellent capability to both transmit data and provide suitable storage
- **50%** have poor or limited analytics capabilities while **16%** believe that their analytics process is fully embedded in the business operation
- **92%** expect that in 2 years they will have implemented digital technologies to improve production efficiency or be best in class

Outcomes

- **83%** stated that they used the data for either anomaly identification or understanding historic trends
- **33%** of responders state that they have the ability to routinely avoid failures through prescribed insights and actions
- **50%** believe that they have demonstrable or quantifiable value from deploying the technology

Barriers

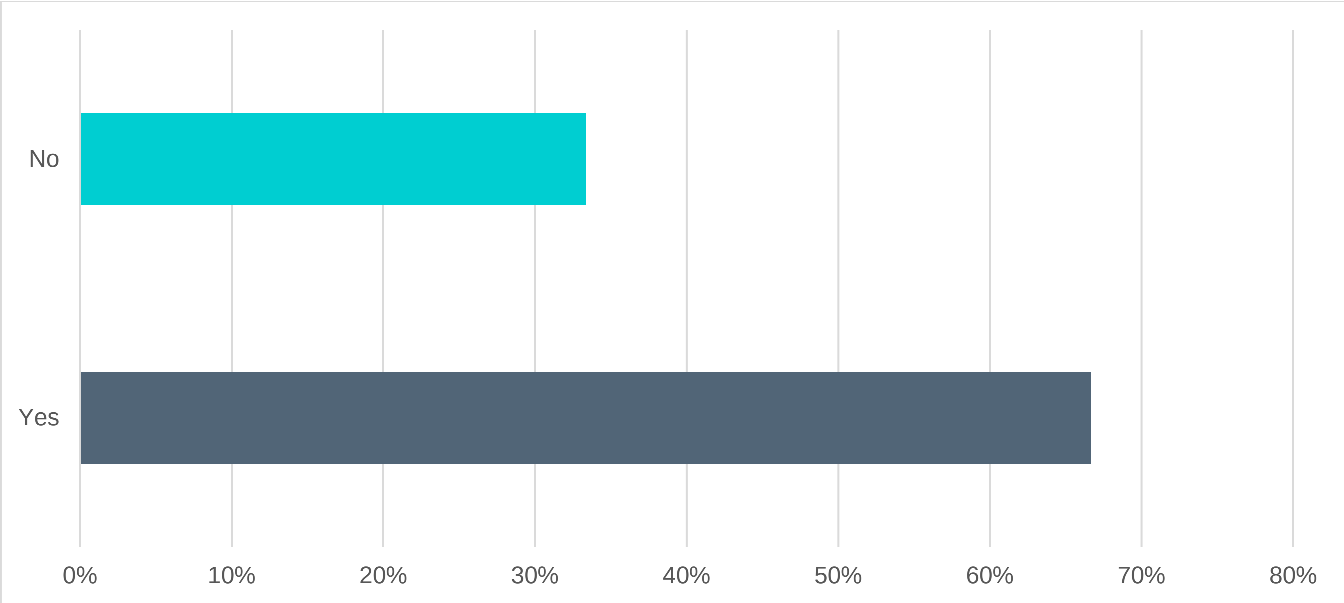
- The main issues arising were the data management and storage constraints, **working with the supply chain** and conflicting corporate initiatives
- **70%** would be prepared to share data for common learning and **83%** would share anonymized data with the supply chain

Initiatives

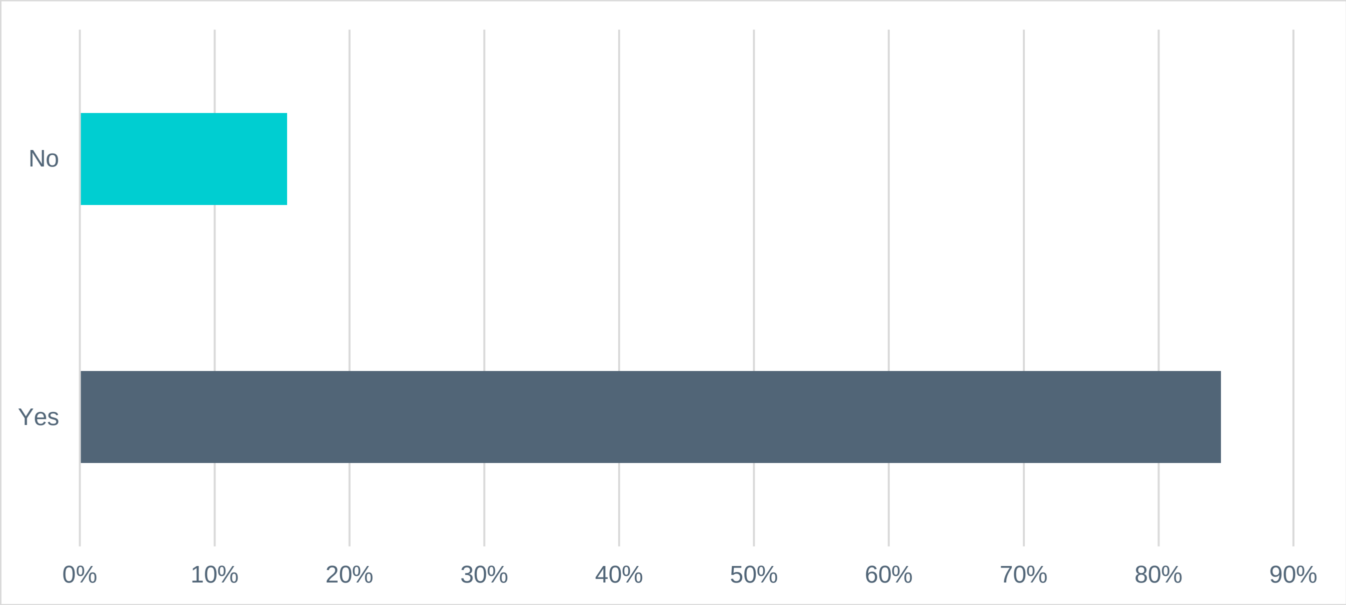
- While **64%** of respondents would be willing to share their operational data for common learning purposes only **45%** would also provide details of specific problems. However, if the data was anonymized then over **90%** would share their data
- **75%** of the respondents stated they would be willing to either pilot new technologies for capturing stranded data sources or contribute to industry sector initiatives and strategies identified from this study

9.2. A2 stakeholder online survey – operator responses (15)

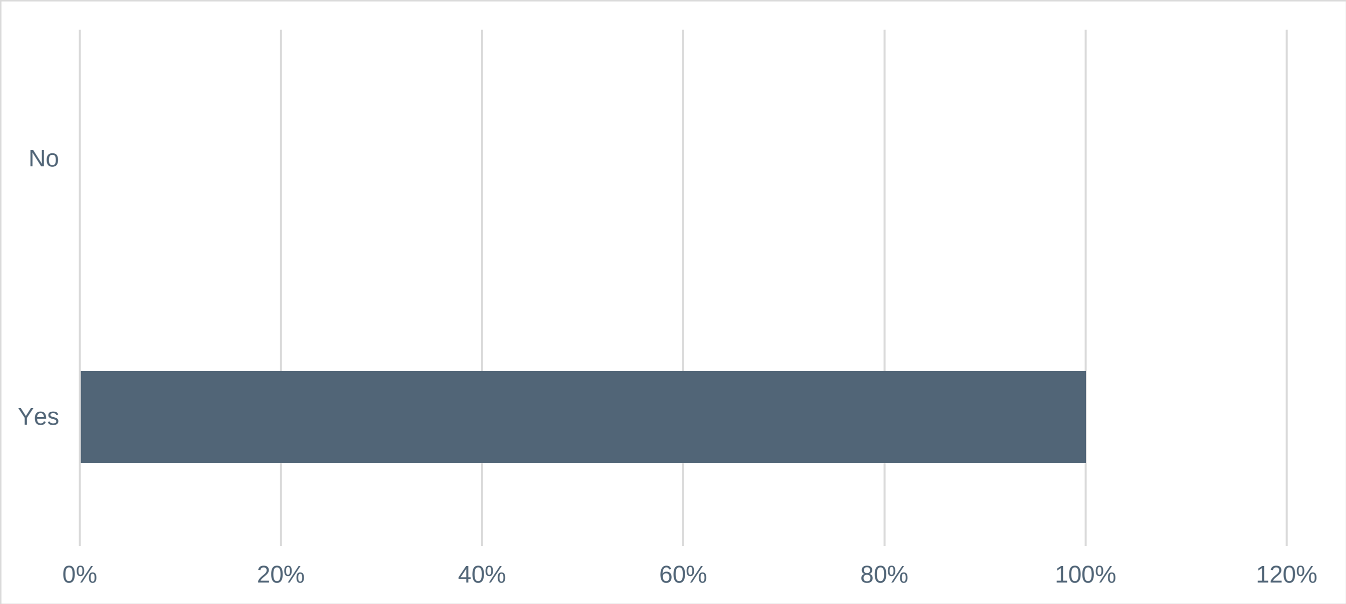
Would your Company be willing to share its full submission related to production efficiency and production losses of last year's OGA Stewardship Survey? (Answered: 11, Skipped: 4)



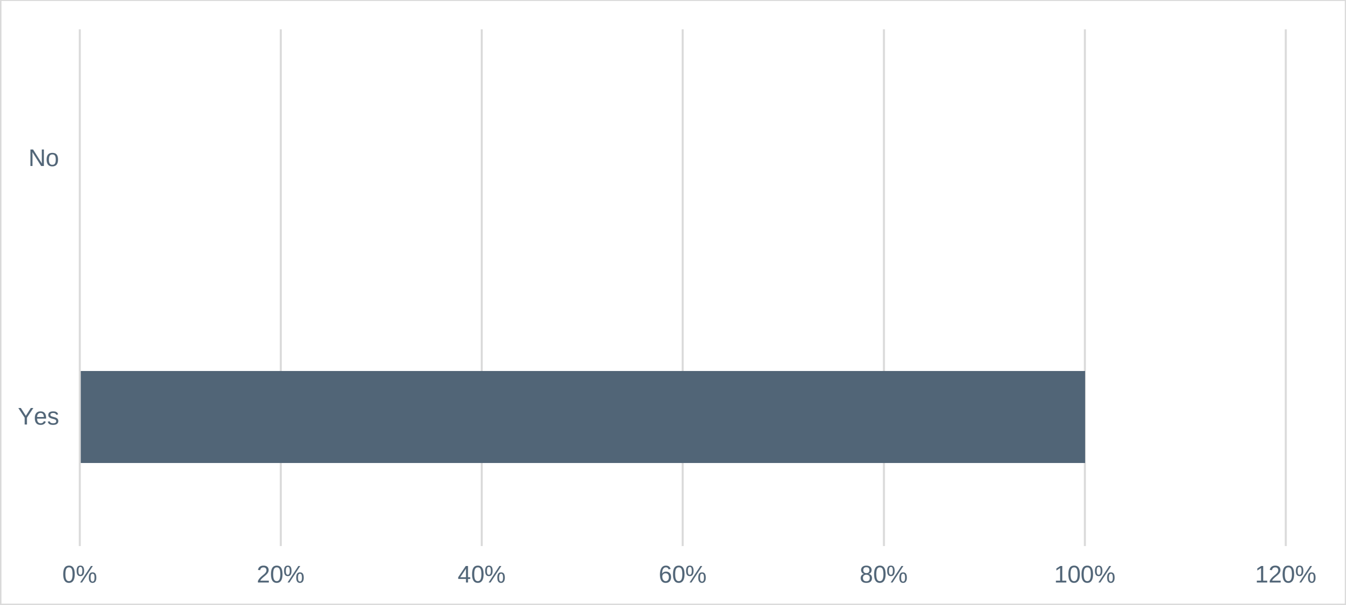
Are you actively using a digital production loss management tool/system to record shortfalls against production potential? (Answered: 12, Skipped: 3)



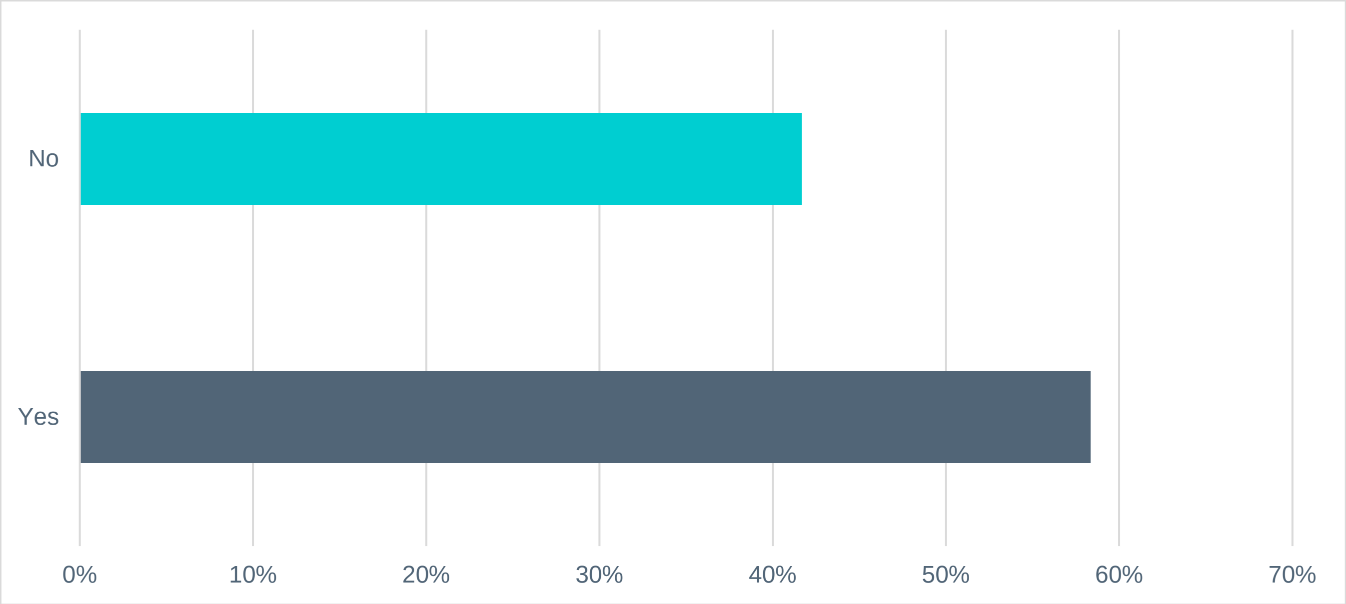
Are you able to identify which operational area(s) each loss can be attributed to? (Answered: 12, Skipped: 3)



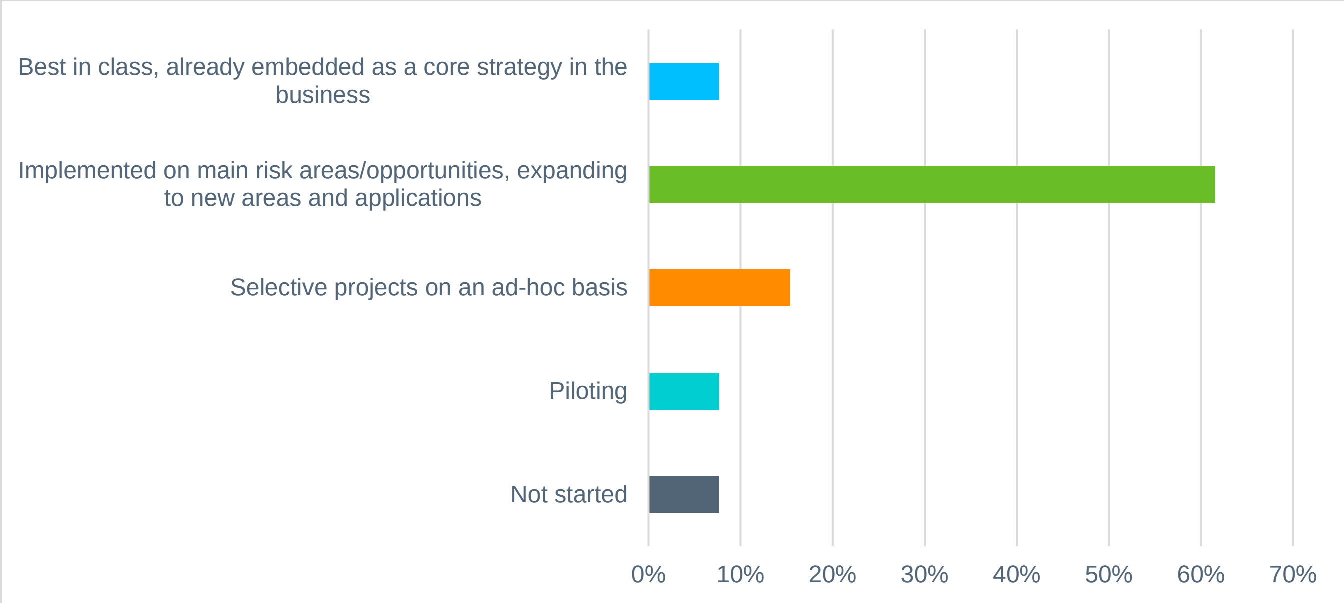
Are you able to identify specific equipment type each loss can be attributed to? (Answered: 12, Skipped: 3)



Does the use of digital and data technologies feature as part of your OGA Asset Stewardship Technology Plans in driving improvement in Production Efficiency? (Answered: 11, Skipped: 4)

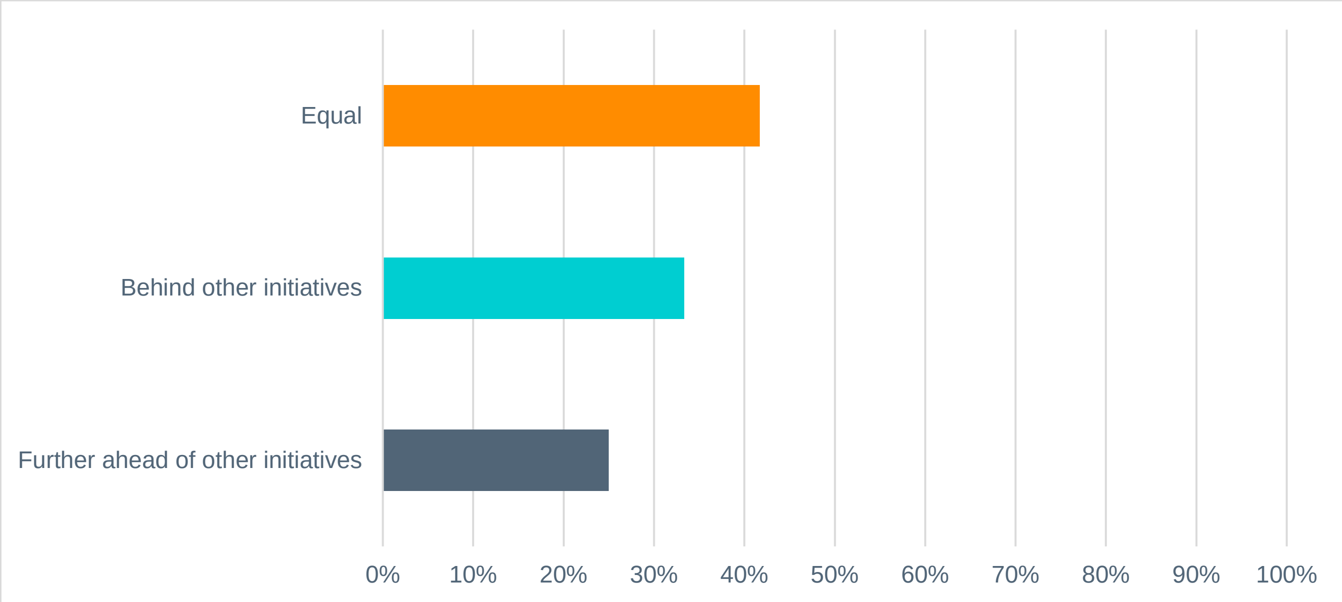


Please indicate the current level of adoption of digital and data technologies to improve production efficiency on your Asset: (Answered: 12, Skipped: 3)



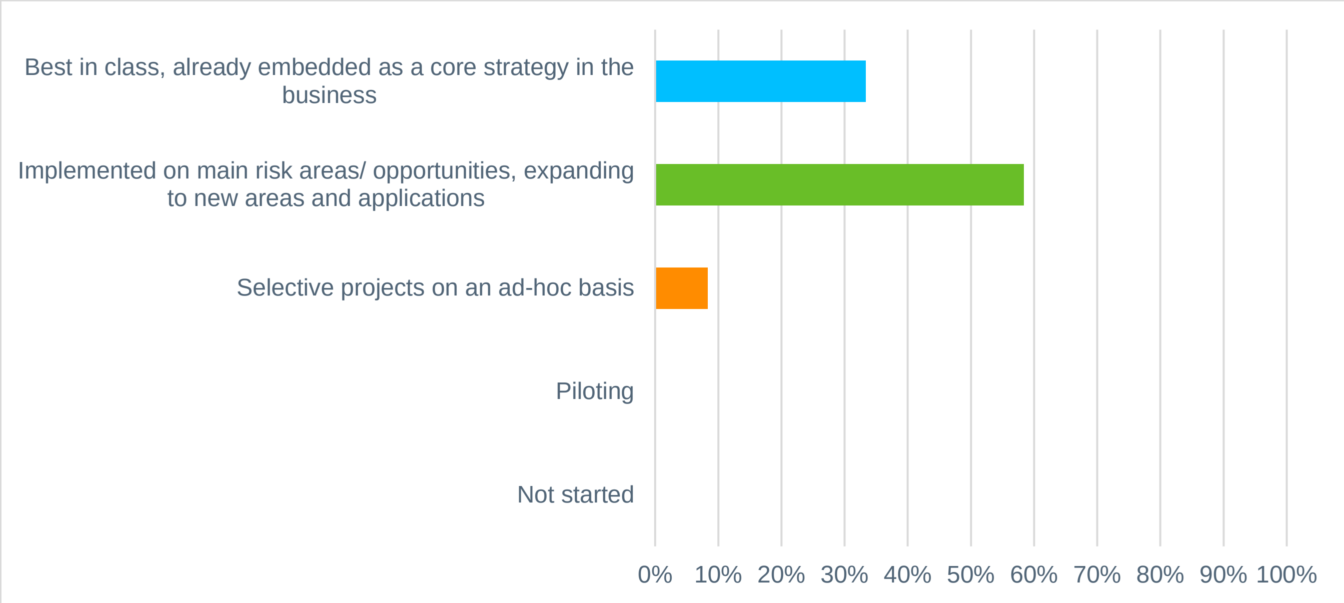
Answer Choices	Responses	
Not started	8.33%	1
Piloting	8.33%	1
Selective projects on an ad-hoc basis	16.67%	2
Implemented on main risk areas/opportunities, expanding to new areas and applications	58.33%	7
Best in class, already embedded as a core strategy in the business	8.33%	1
TOTAL		12

Is this further behind or further ahead than the use of digital and data technologies in other areas of the Asset e.g. reservoir modelling, well optimisation, supply chain etc? (Answered: 12, Skipped: 3)



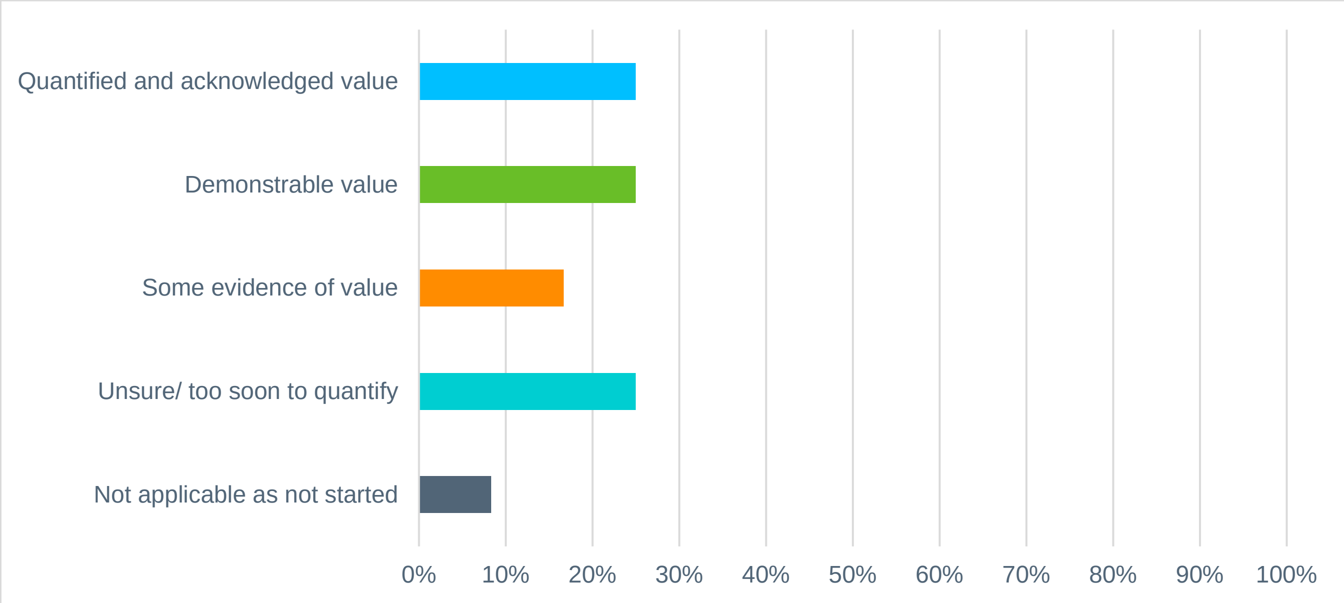
Answer Choices	Responses	
Further ahead of other initiatives	25.00%	3
Behind other initiatives	33.33%	4
Equal	41.67%	5
TOTAL		12

Regarding the application of digital and data technologies to improve production efficiency, where do you think you will be in 2 years' time? (Answered: 12, Skipped: 3)



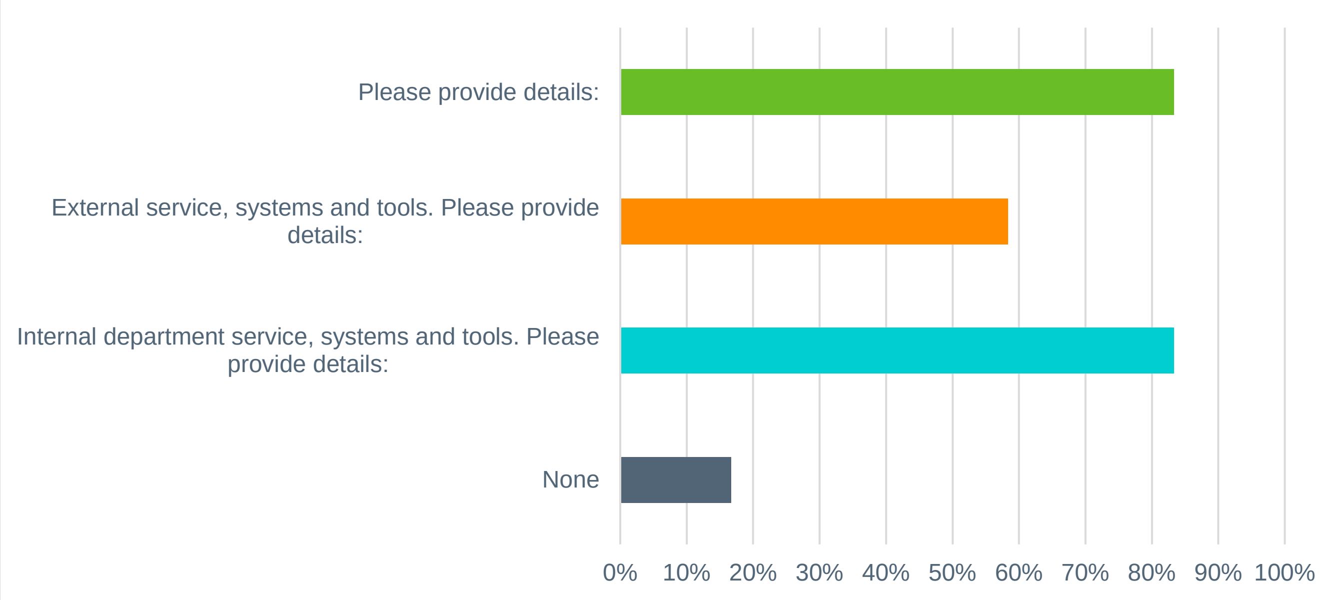
Answer Choices	Responses	
Not started	0%	0
Piloting	0%	0
Selective projects on an ad-hoc basis	8.33%	1
Implemented on main risk areas/ opportunities, expanding to new areas and applications	58.33%	7
Best in class, already embedded as a core strategy in the business	33.33%	4
TOTAL		12

Please provide your assessment of the impact on production efficiency of digital and data technologies to your Asset so far? (Answered: 12, Skipped: 3)



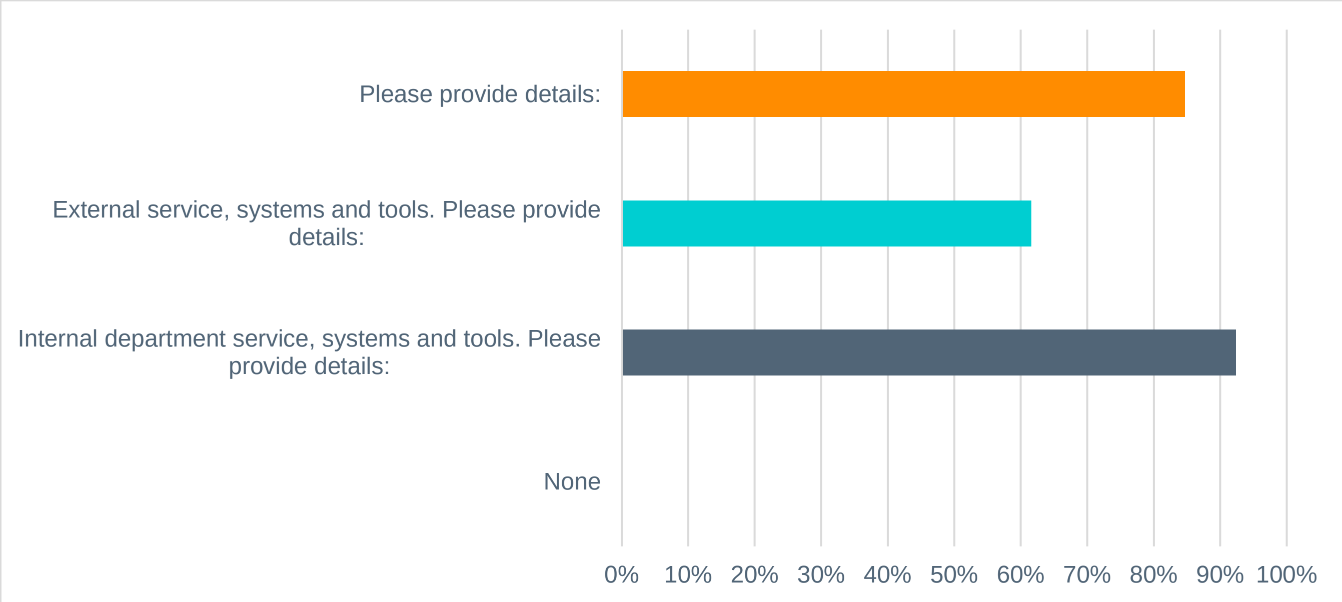
Answer Choices	Responses	
Not applicable as not started	8.33%	1
Unsure/ too soon to quantify	25.00%	3
Some evidence of value	16.67%	2
Demonstrable value	25.00%	3
Quantified and acknowledged value	25.00%	3
TOTAL		12

Please provide details of the types of data technologies, systems and tools that your Asset uses. Digital Sensors (ability to automatically correct operational data): (Answered: 12, Skipped: 3)



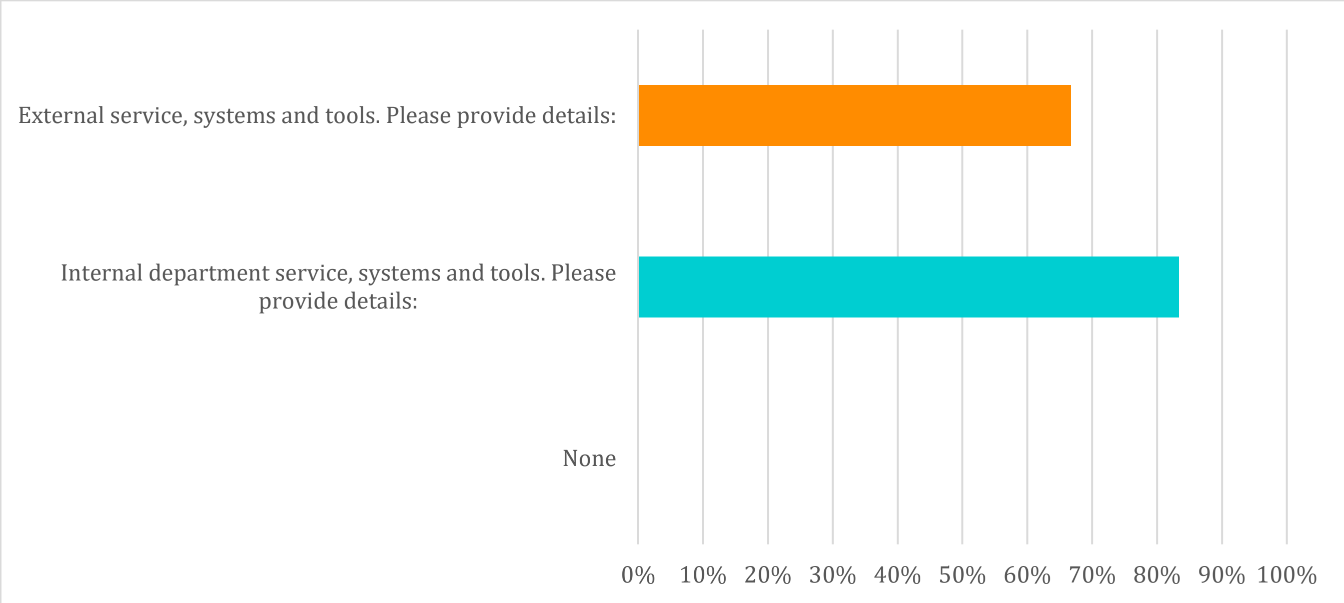
Answer Choices	Responses	
None	16.67%	2
Internal department service, systems and tools. Please provide details:	83.33%	10
External service, systems and tools. Please provide details:	58.33%	7
Please provide details:	83.33%	10
TOTAL		12

Please provide details of the types of data technologies, systems and tools that your Asset uses. Data Transmission/Storage/Management (ability to send data onshore and offshore): (Answered: 12, Skipped: 3)



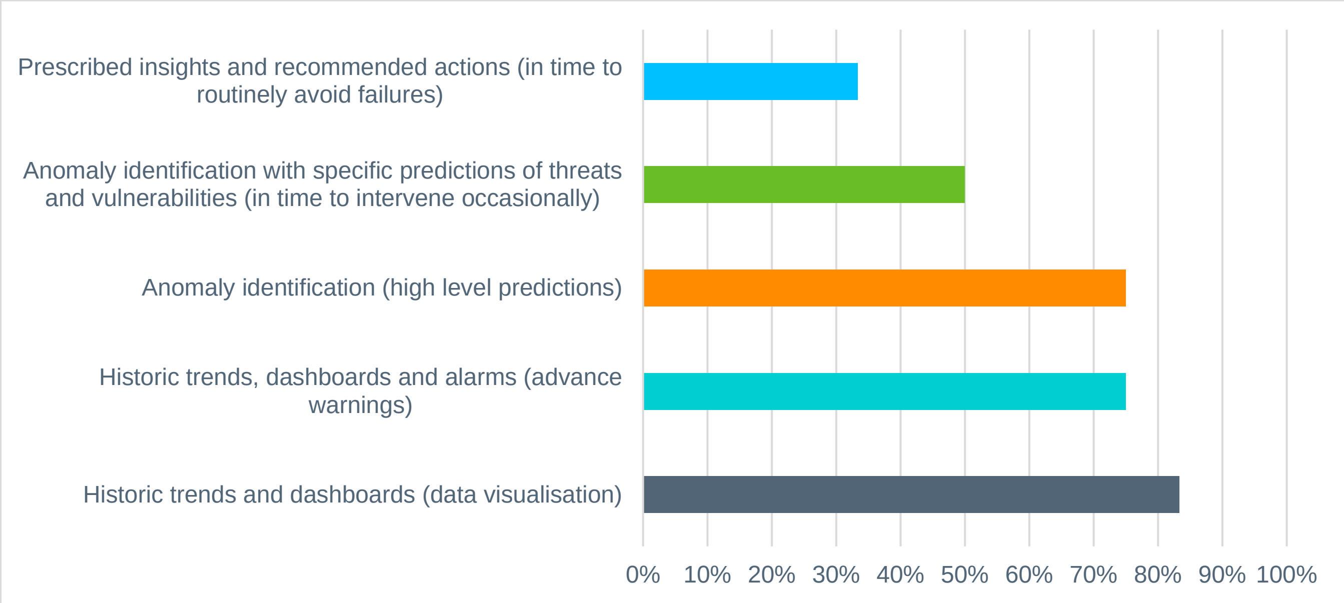
Answer Choices	Responses	
None	0.00%	0
Internal department service, systems and tools. Please provide details:	91.67%	11
External service, systems and tools. Please provide details:	58.33%	7
Please provide details:	83.33%	10
TOTAL		12

Please provide details of the types of data technologies, systems and tools that your Asset uses. Data Analytics (ability to analyse operational data and make predictions): (Answered: 12, Skipped: 3)



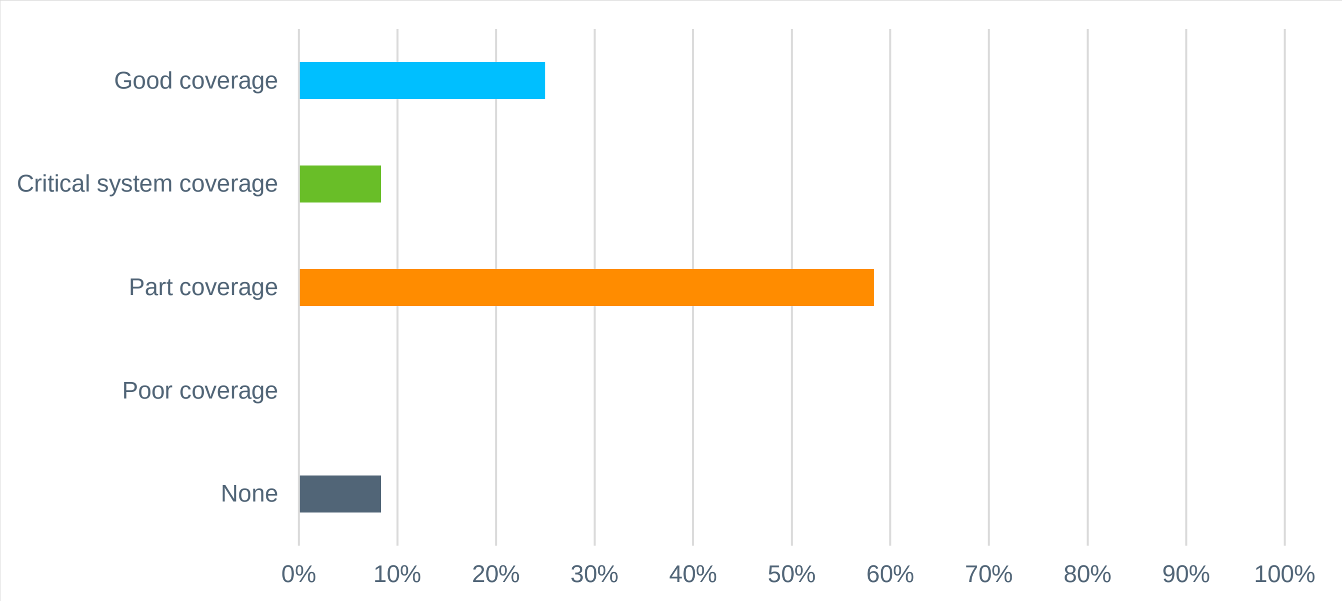
Answer Choices	Responses	
None	0%	0
Internal department service, systems and tools.	83.33%	10
External service, systems and tools.	66.67%	8
TOTAL		12

In general, across the services, systems and tools in use, please indicate the level of capabilities provided. (Answered: 12, Skipped: 3)



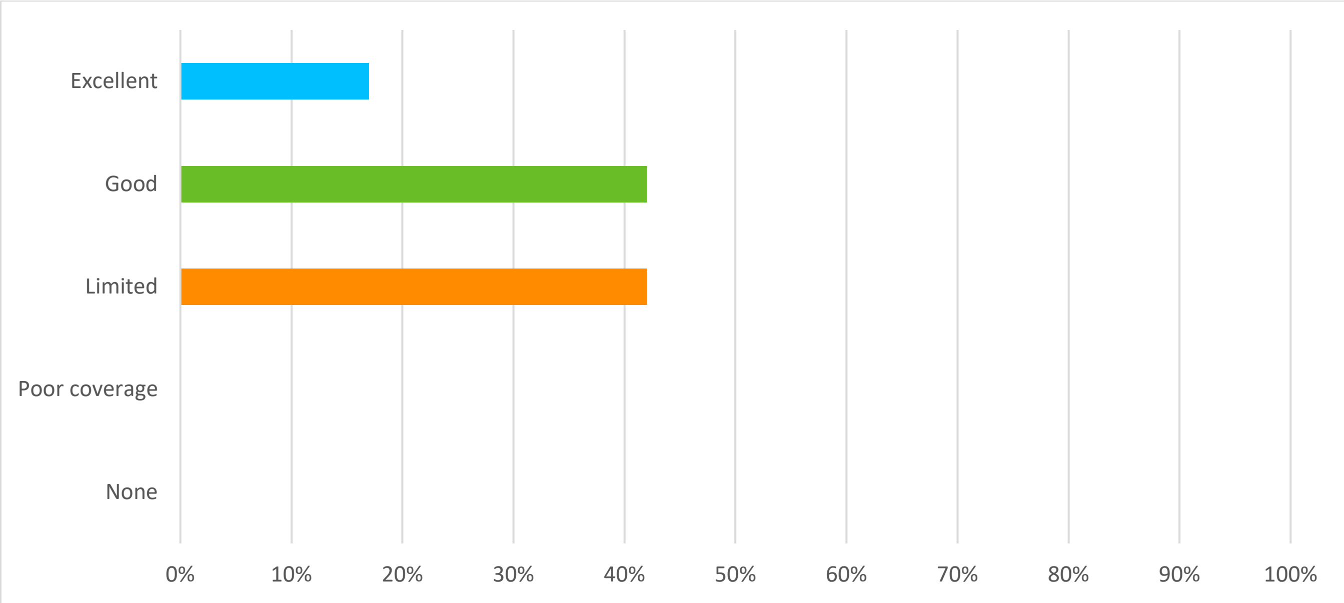
Answer Choices	Responses	
Historic trends and dashboards (data visualisation)	83.33%	10
Historic trends, dashboards and alarms (advance warnings)	75.00%	9
Anomaly identification (high level predictions)	75.00%	9
Anomaly identification with specific predictions of threats and vulnerabilities (in time to intervene occasionally)	50.00%	6
Prescribed insights and recommended actions (in time to routinely avoid failures)	33.33%	4
	Answered	12

Please score the Asset's capabilities to deploy data technologies to mitigate losses, improve uptime and prevent future failures. Please provide details of each technology employed. Digital sensors (ability to automatically correct operational data) (Answered: 12, Skipped: 3)



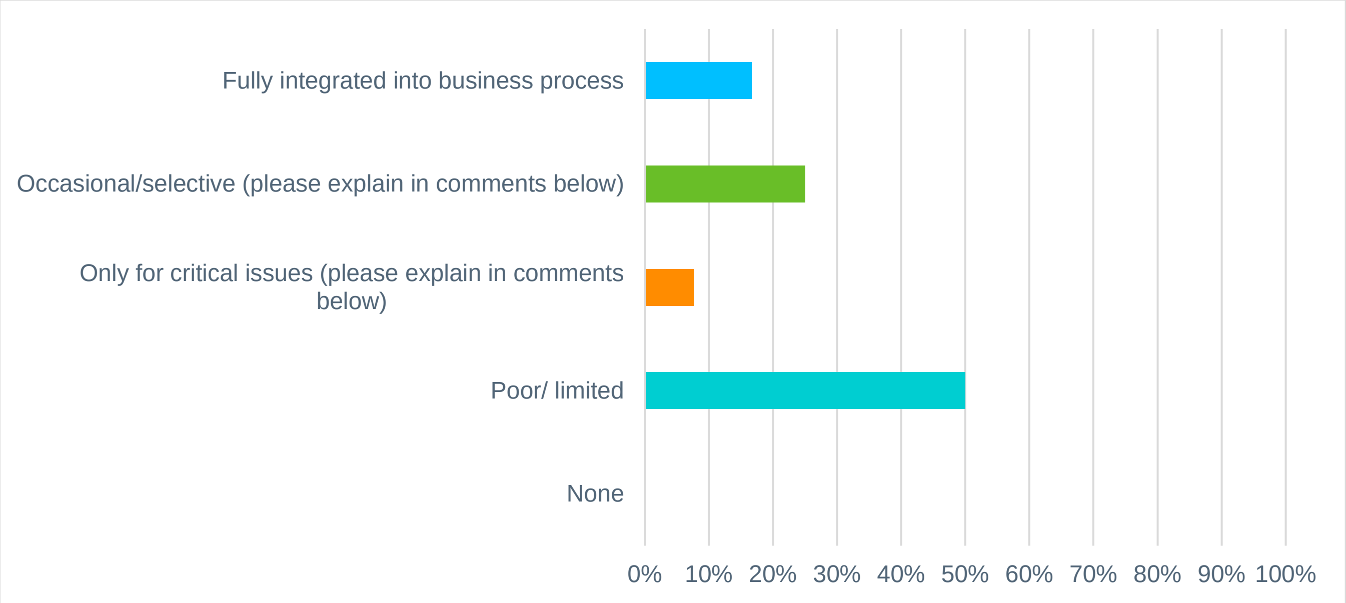
Answer Choices	Responses	
None	8.33%	1
Poor coverage	0.00%	0
Part coverage	58.33%	7
Critical system coverage	8.33%	1
Good coverage	25.00%	3
Comments:		12
	Answered	12

Please score the Asset's capabilities to deploy data technologies to mitigate losses, improve uptime and prevent future failures. Please provide details of each technology employed. Data Transmission/ Storage/ Management (ability to send data onshore and store) (Answered: 12, Skipped: 3)



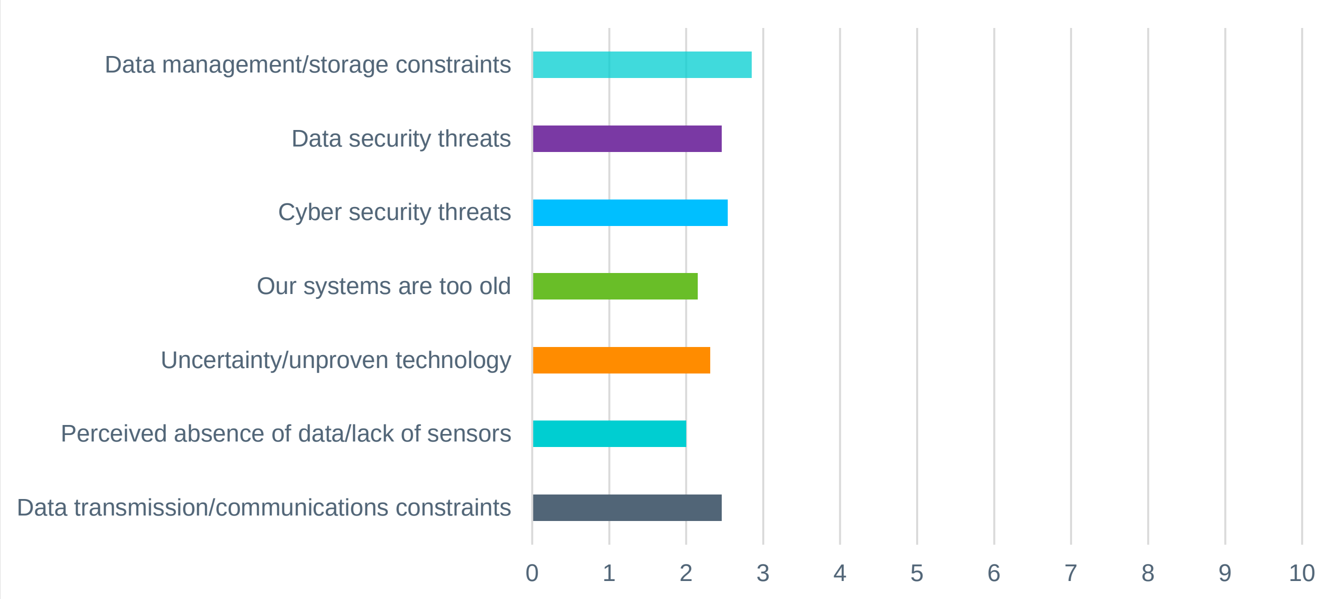
Answer Choices	Responses	
None	0%	0
Poor coverage	0%	0
Limited	41.67%	5
Good	41.67%	5
Excellent	16.67%	2
TOTAL		12

Please score the Asset's capabilities to deploy data technologies to mitigate losses, improve uptime and prevent future failures. Please provide details of each technology employed. Data Analytics (ability to analyse operational data and make predictions): (Answered: 12, Skipped: 3)



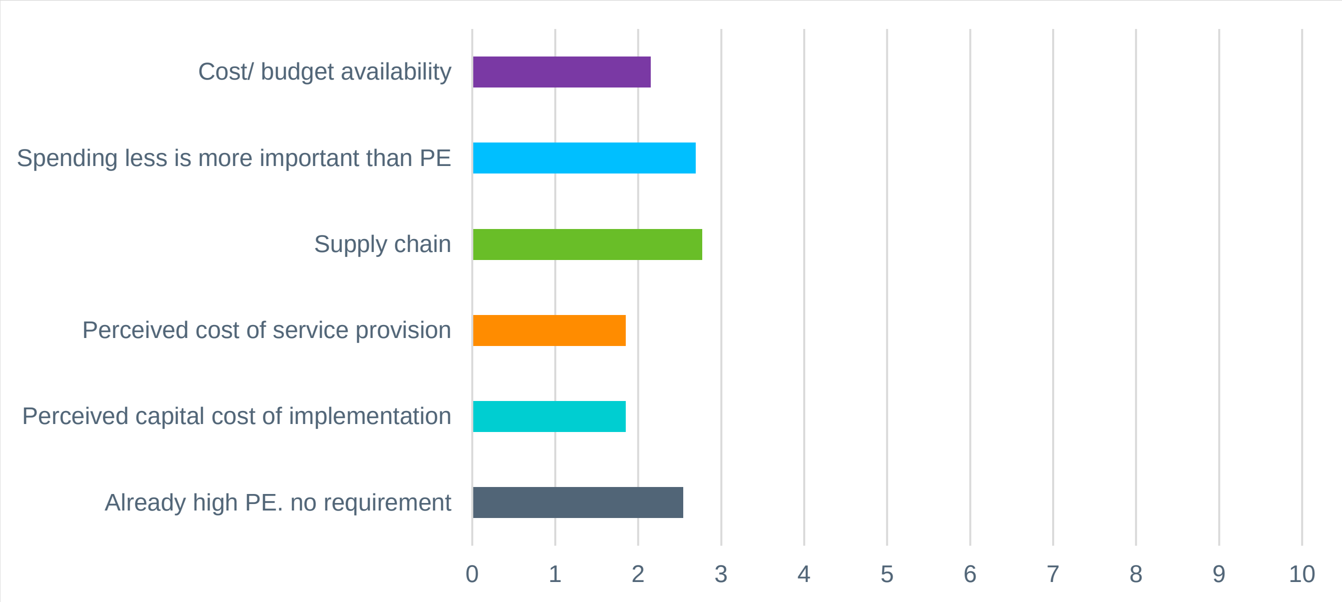
Answer Choices	Responses	
None	0%	0
Poor/ limited	50.00%	6
Only for critical issues (please explain in comments below)	8.33%	1
Occasional/selective (please explain in comments below)	25.00%	3
Fully integrated into business process	16.67%	2
TOTAL	Answered	12

What would you consider to be the main barriers to adoption of a digital data led PE improvement initiative in your Asset? Please rank each element as follows: 1. Barrier 2. Partial Barrier 3. No Barrier Technical (Answered: 12, Skipped: 3)



	1		2		3		Total	Weighted Average
Data transmission/communications constraints	0%	0	50%	6	50%	6	12	2.50
Perceived absence of data/lack of sensors	25%	3	50%	6	25%	3	12	2
Uncertainty/unproven technology	16.67%	2	41.67%	5	41.67%	5	12	2.25
Our systems are too old	0%	0	91.67%	11	8.33%	1	12	2.08
Cyber security threats	0%	0	41.67%	5	58.33%	7	12	2.58
Data security threats	0%	0	50%	6	50%	6	12	2.50
Data management/storage constraints	8.33%	1	0%	0	91.67%	11	12	2.83

What would you consider to be the main barriers to adoption of a digital data led PE improvement initiative in your Asset? Please rank each element as follows: 1. Barrier2. Partial Barrier 3. No Barrier Commercial/Financial (Answered: 12, Skipped: 3)

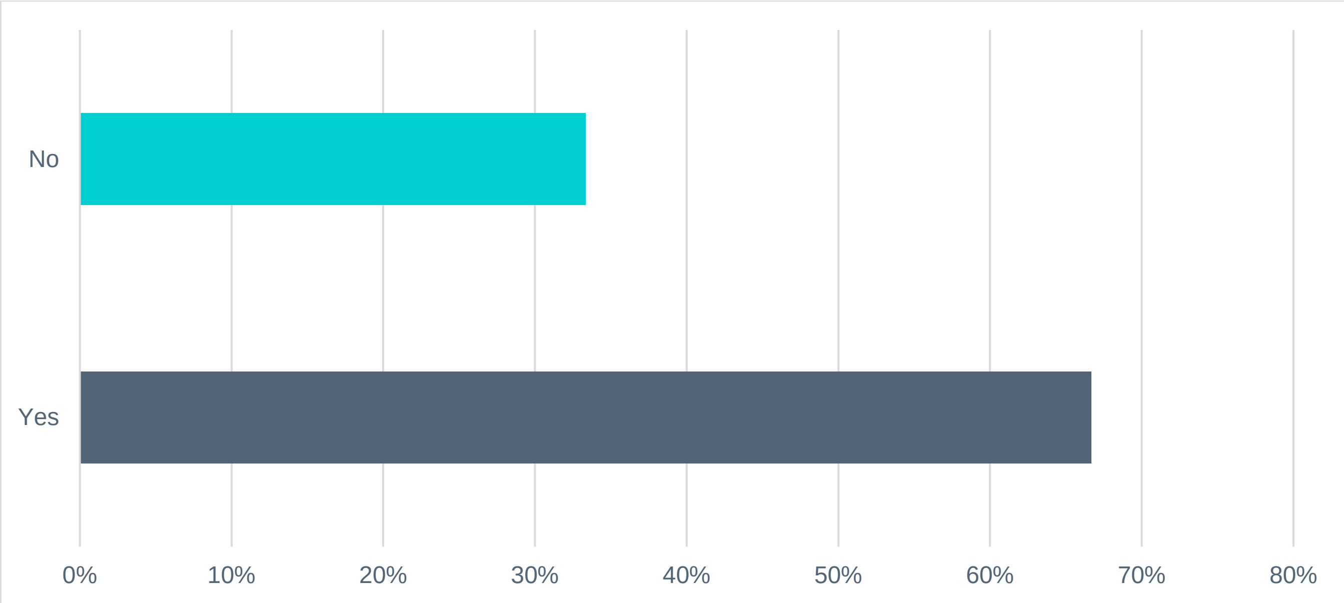


	1		2		3		Total	Weighted Average
Already high PE. no requirement	16.67%	2	16.67%	2	66.67%	8	12	2.50
Perceived capital cost of implementation	33.33%	4	41.67%	5	25%	3	12	1.92
Perceived cost of service provision	25%	3	66.67%	8	8.33%	1	12	1.83
Supply chain	8.33%	1	8.33%	1	83.33%	10	12	2.75
Spending less is more important than PE	0%	0	33.33%	4	66.67%	8	12	2.67
Cost/ budget availability	8.33%	1	66.67%	8	25%	3	12	2.17

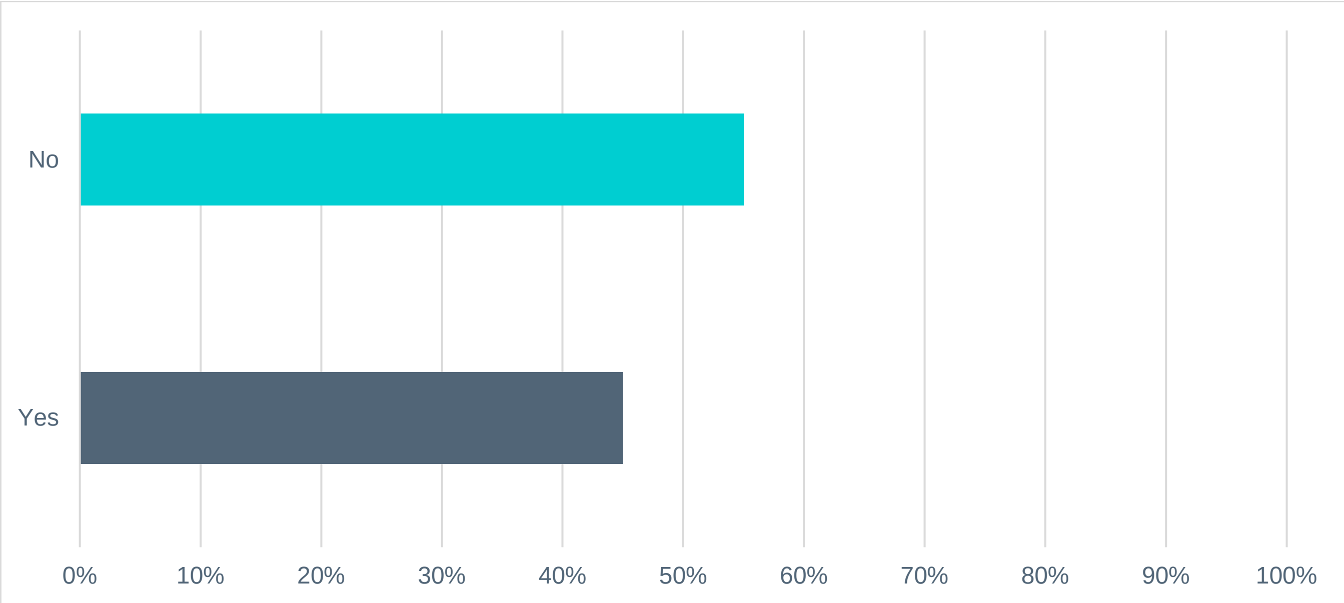
What would you consider to be the main barriers to adoption of a digital data led PE improvement initiative in your Asset? Please rank each element as follows: 1. Barrier 2. Partial Barrier 3. No Barrier Organisational (Answered: 12, Skipped: 3)

	1		2		3		Total	Weighted Average
Culture/People/Protectiveness	0%	0	58.33%	7	41.67%	5	12	2.42
It's more IT than operations/ lack of inter department/ asset collaboration	0%	0	33.33%	4	66.67%	8	12	2.67
Lack of knowledge/ understanding or confusion on what's possible	8.33%	1	83.33%	10	8.33%	1	12	2
Corporate initiatives/ conflicts driven from HQ (overseas)	0%	0	25%	3	75%	9	12	2.75
No time to look at new initiatives/perceived time to implement	8.33%	1	66.67%	8	25%	3	12	2.17
Lack of belief in offering	16.67%	2	50.00%	6	33.33%	4	12	2.17
Fear of being first/ early adopter/ personal risk	8.33%	1	33.33%	4	58.33%	7	12	2.50
Contractors dependency/ not our decision	0%	0	33.33%	4	66.67%	8	12	2.67
Too challenging for my company's resources	0%	0	33.33%	4	66.67%	8	12	2.67

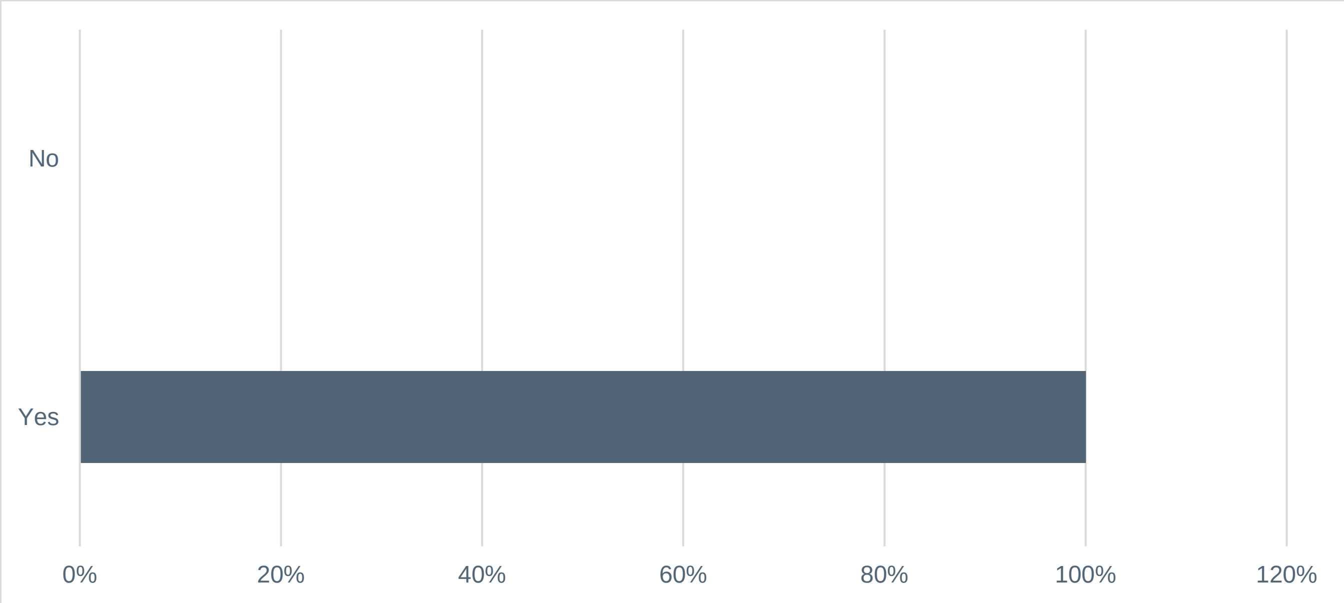
What is your policy/ willingness (subject to specific confidentiality agreements) to share operational data for enhanced capabilities? You would be willing to share your operational data with other operators for common learning potential? (Answered: 11, Skipped: 4)



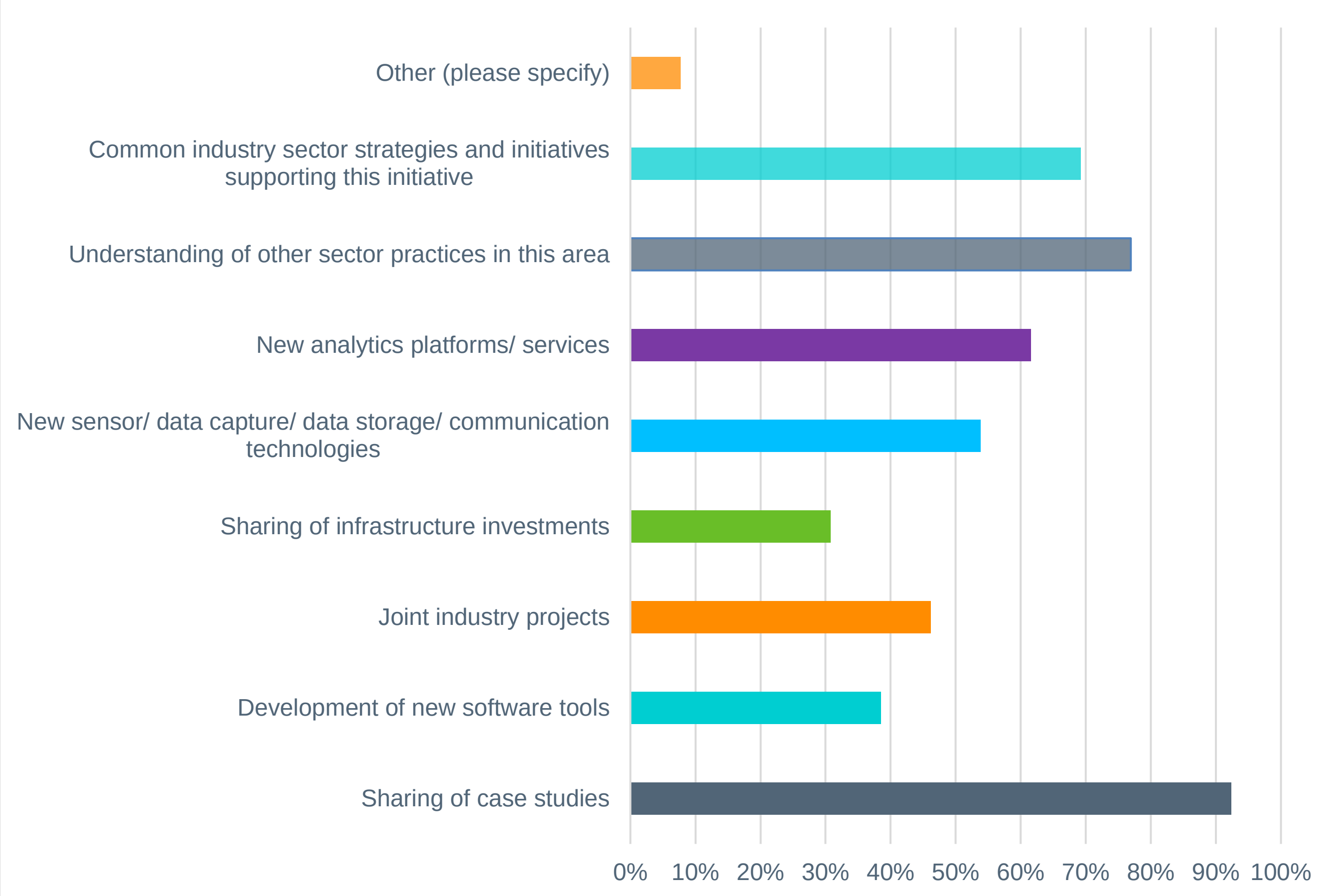
You would be willing to share your operational data along with specific problems with the supply chain? (Answered: 11, Skipped: 4)



If you selected no to either of the above, would you be willing to share if the operational data was anonymised? (Answered: 7, Skipped: 8)

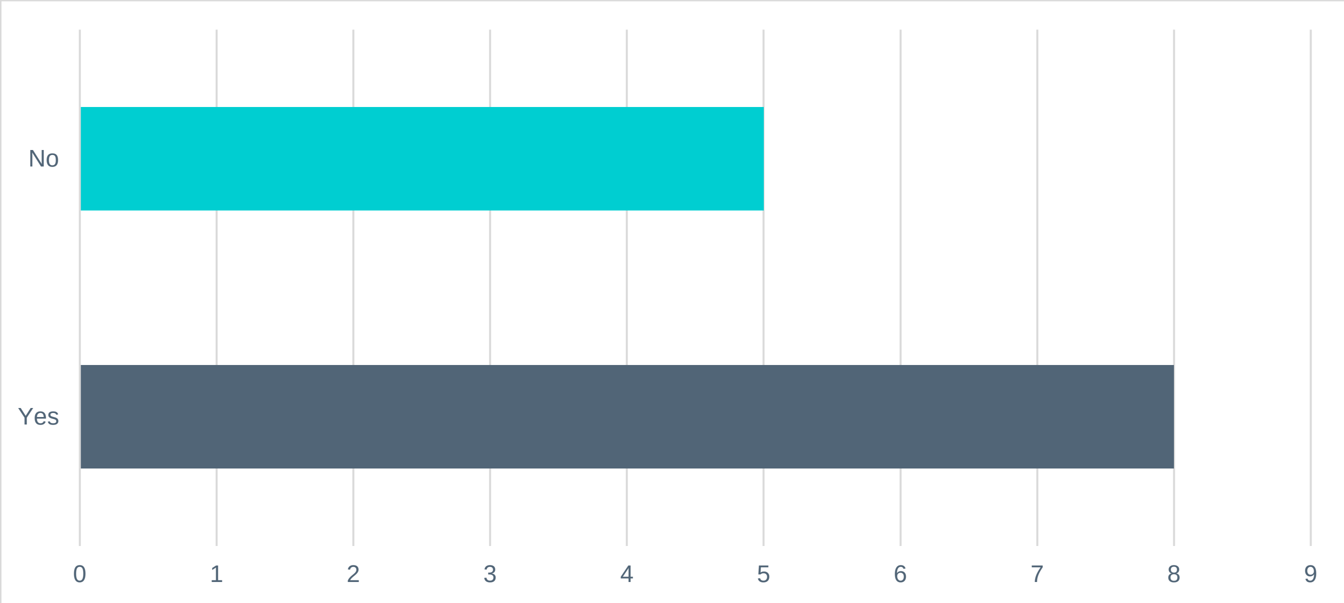


What would you find helpful if achieved through industry collaboration in this area? (Answered: 12, Skipped: 3)

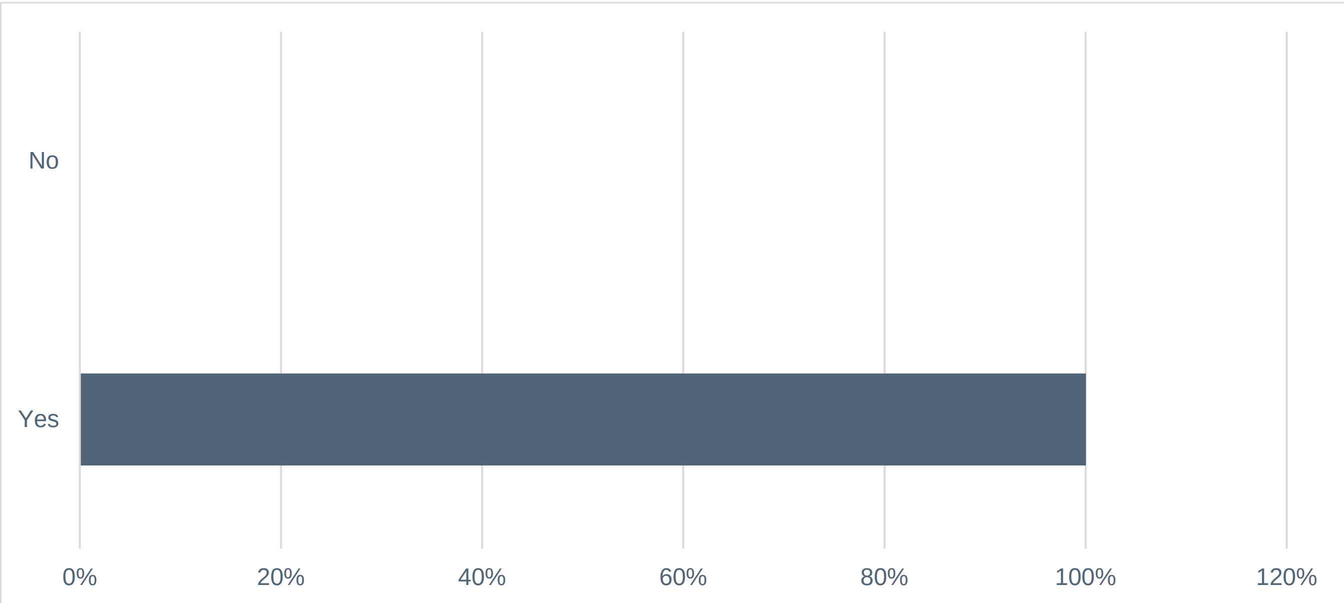


Sharing of case studies	92.31%	12
Development of new software tools	38.46%	5
Joint industry projects	46.15%	6
Sharing of infrastructure investments	30.77%	4
New sensor/ data capture/ data storage/ communication technologies	53.85%	7
New analytics platforms/ services	61.54%	8
Understanding of other sector practices in this area	76.92%	10
Common industry sector strategies and initiatives supporting this initiative	69.23%	9
Other (please specify)	7.69%	1
	Answered	13

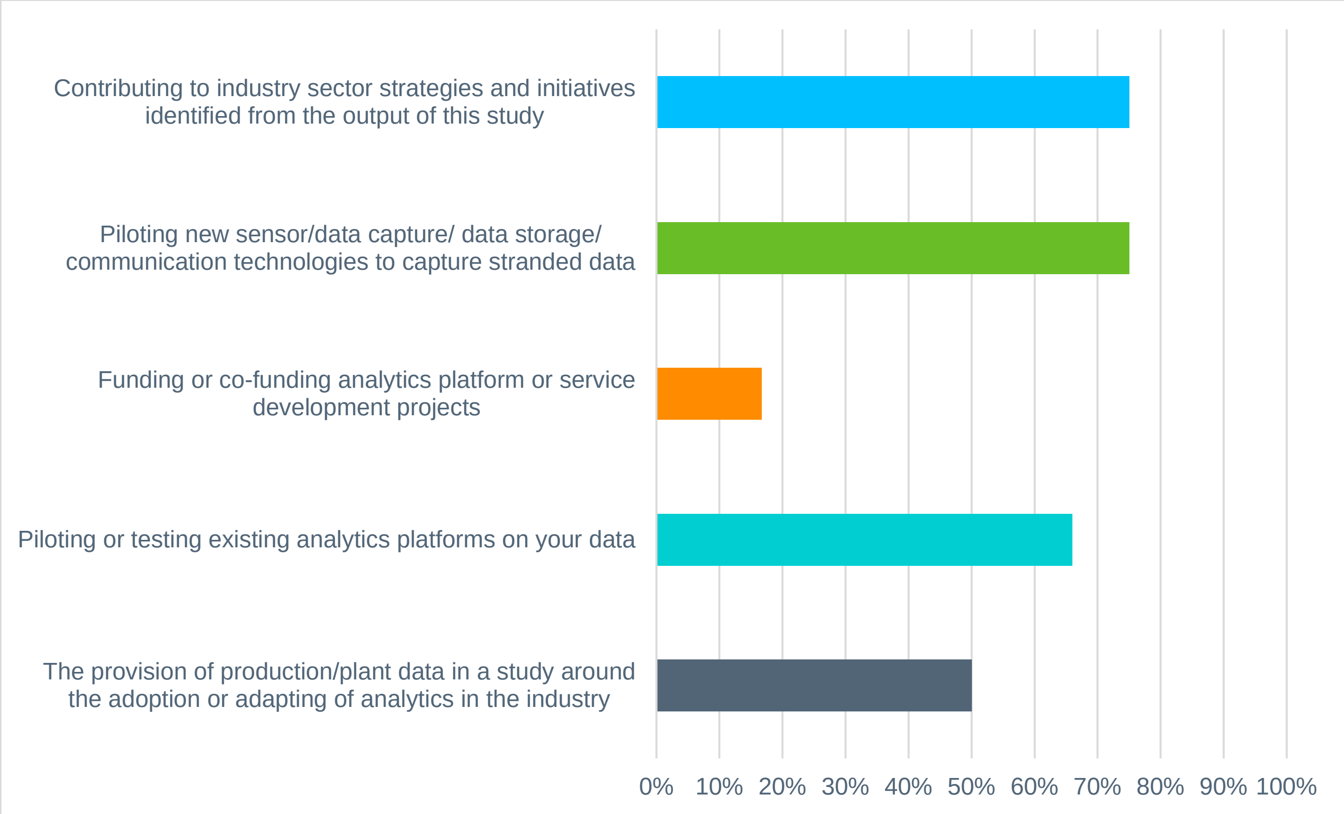
Do you have case studies which demonstrate where an improvement in production efficiency has been made through digital and data technologies? (Answered: 12, Skipped: 3)



If you answered yes to above, would you be willing to share these with industry? (Answered: 7, Skipped: 8)



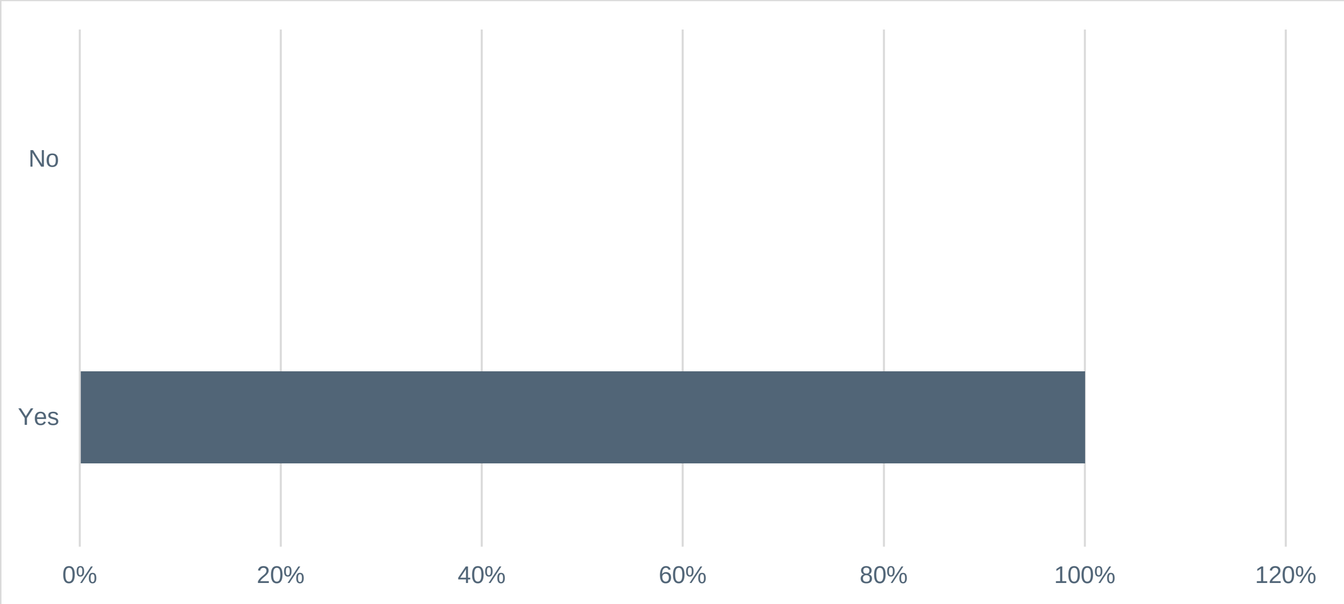
Would you be willing to participate in any of the following? (Answered: 12, Skipped: 3)



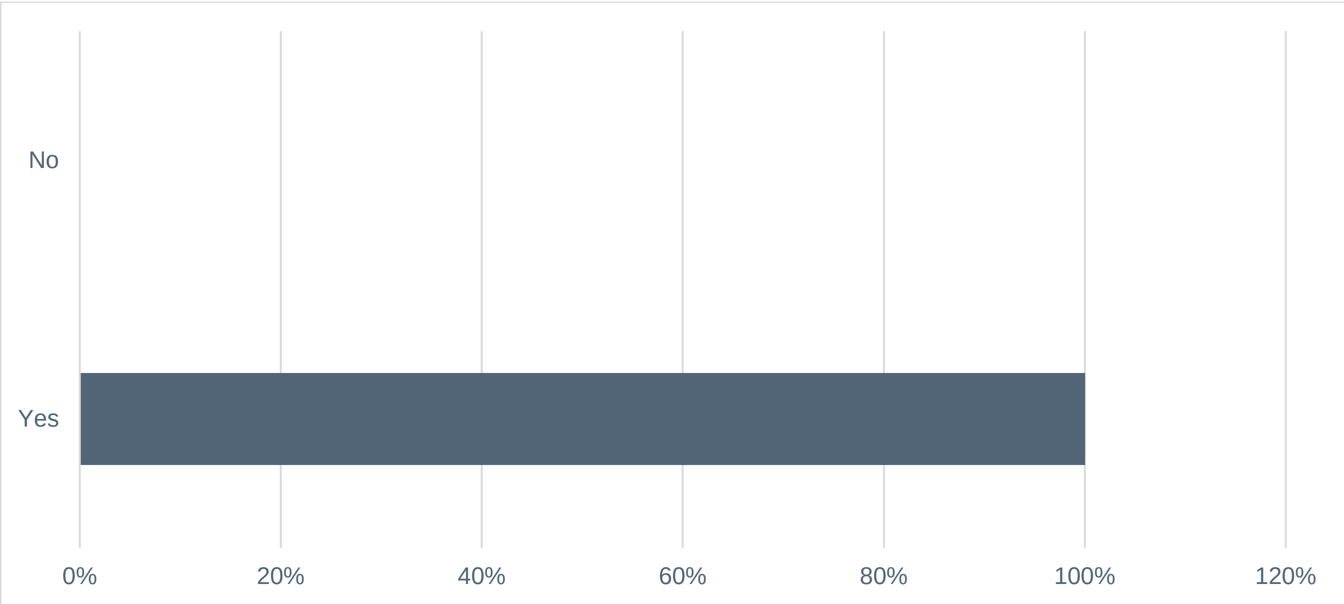
ANSWER CHOICES	RESPONSES	
The provision of production/plant data in a study around the adoption or adapting of analytics in the industry	50.00%	6
Piloting or testing existing analytics platforms on your data	66.67%	8
Funding or co-funding analytics platform or service development projects	16.67%	2
Piloting new sensor/data capture/ data storage/ communication technologies to capture stranded data	75.00%	9
Contributing to industry sector strategies and initiatives identified from the output of this study	75.00%	9
TOTAL		12

9.3. A3 Stakeholder Online Survey – Vendor responses (5)

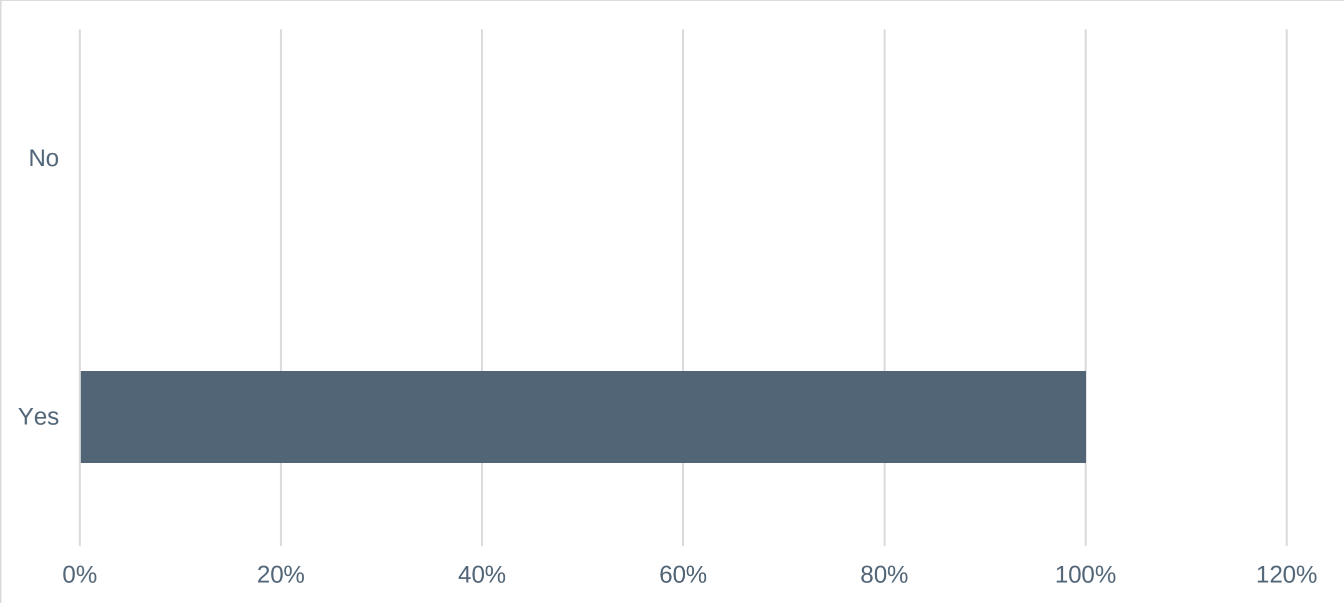
Are you actively using a digital production loss management tool/system to record shortfalls against production potential? (Answered: 1, Skipped: 4)



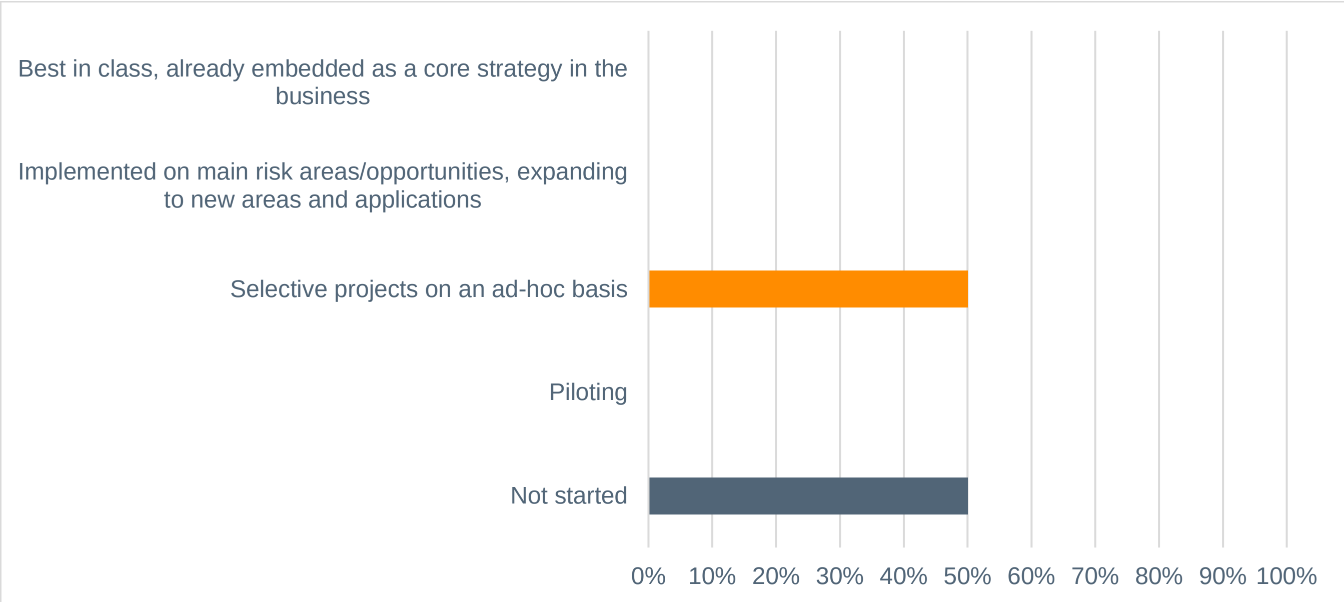
Are you able to identify which operational area(s) each loss can be attributed to?



Are you able to identify specific equipment type each loss can be attributed to? (Answered: 1, Skipped: 4)

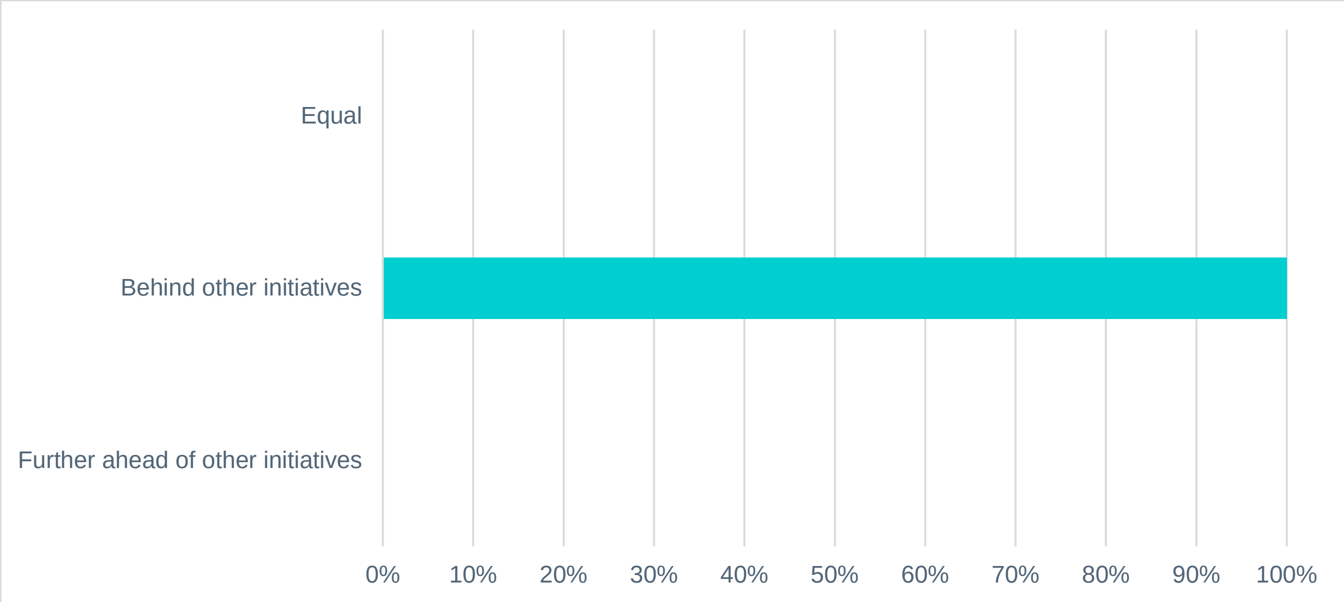


Please indicate your understanding of the current level of adoption of digital and data technologies to improve Production Efficiency: (Answered: 2, Skipped: 3)



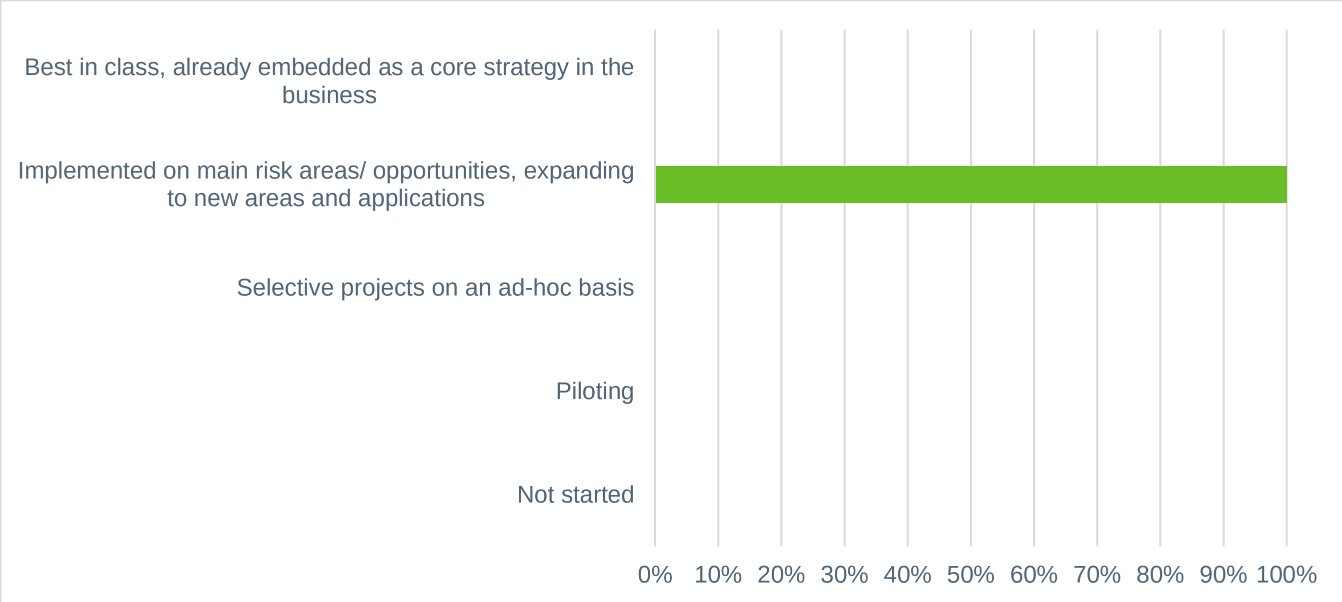
Not started	50.00%	1
Piloting	0.00%	0
Selective projects on an ad-hoc basis	50.00%	1
Implemented on main risk areas/opportunities, expanding to new areas and applications	0.00%	0
Best in class, already embedded as a core strategy in the business	0.00%	0
	Answered	2

In your opinion, is this further behind or further ahead than the use of digital and data technologies in other areas e.g. reservoir modelling, well optimization, supply chain etc? (Answered: 2, Skipped: 3)



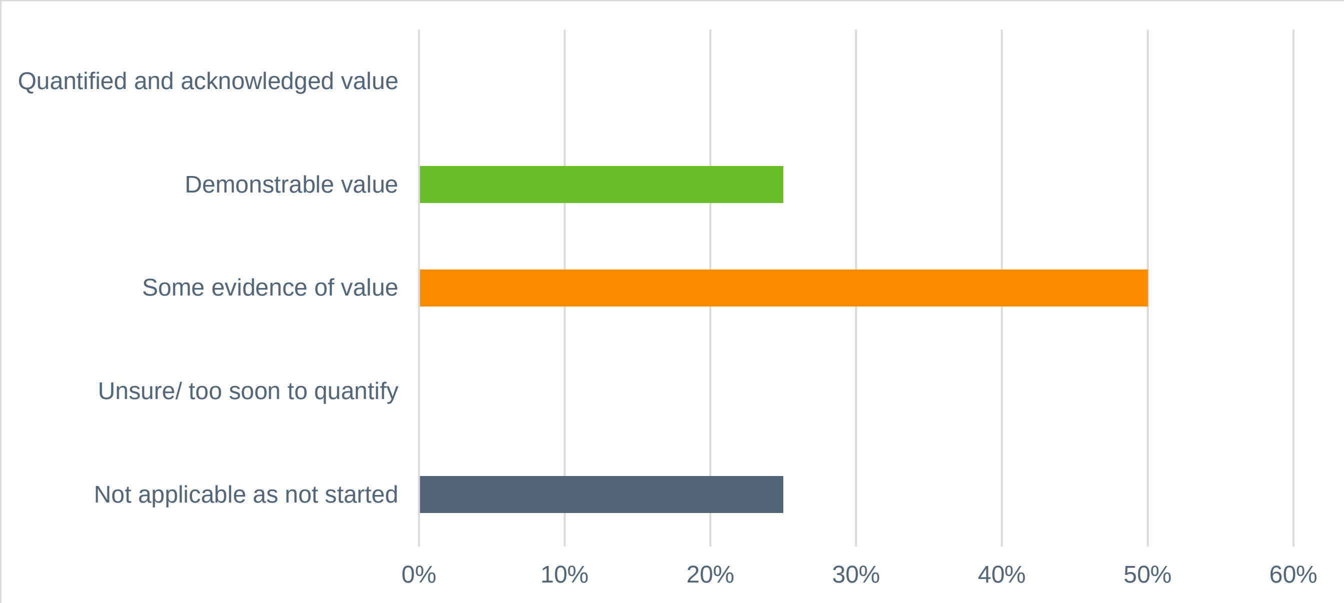
Further ahead of other initiatives	0.00%	0
Behind other initiatives	100.00%	2
Equal	0.00%	0
	Answered	2
	Skipped	3

Regarding the application of digital and data technologies to improve Production Efficiency, where do you think, in your opinion, the industry will be in 2 years' time? (Answered: 4, Skipped: 1)



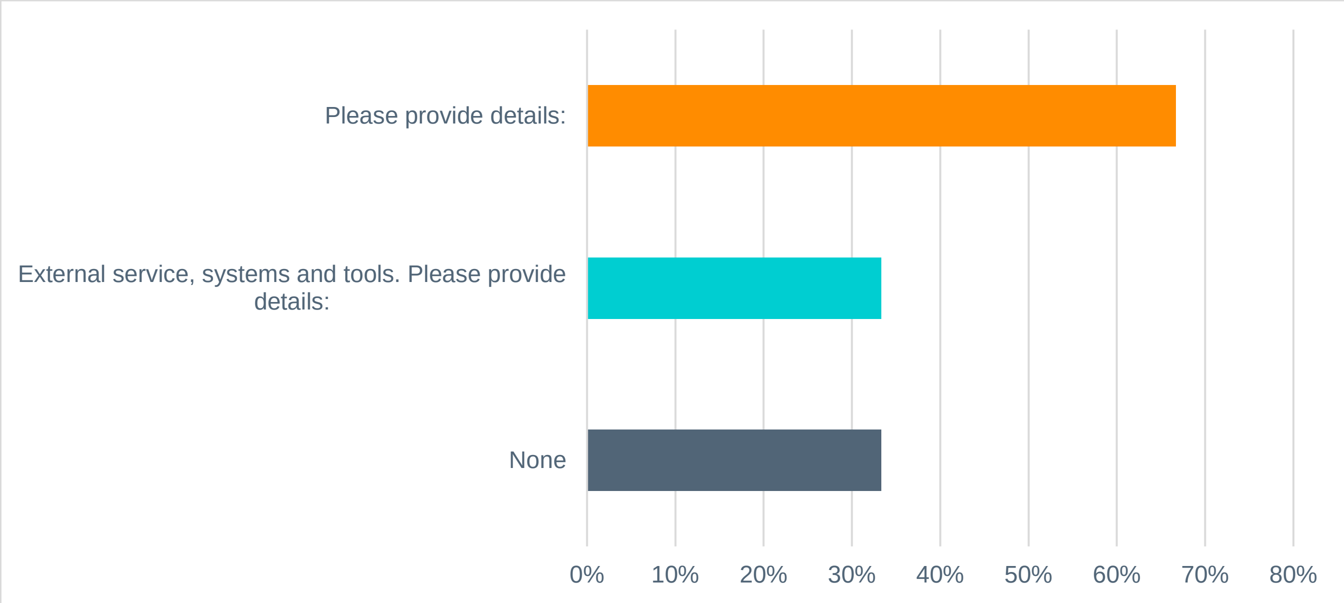
Not started	0.00%	0
Piloting	0.00%	0
Selective projects on an ad-hoc basis	0.00%	0
Implemented on main risk areas/ opportunities, expanding to new areas and applications	100.00%	4
Best in class, already embedded as a core strategy in the business	0.00%	0
	Answered	4
	Skipped	1

Please provide your assessment of where you believe the impact of Production Efficiency of digital and data technologies is being felt by UKCS Assets so far? (Answered: 4, Skipped: 1)



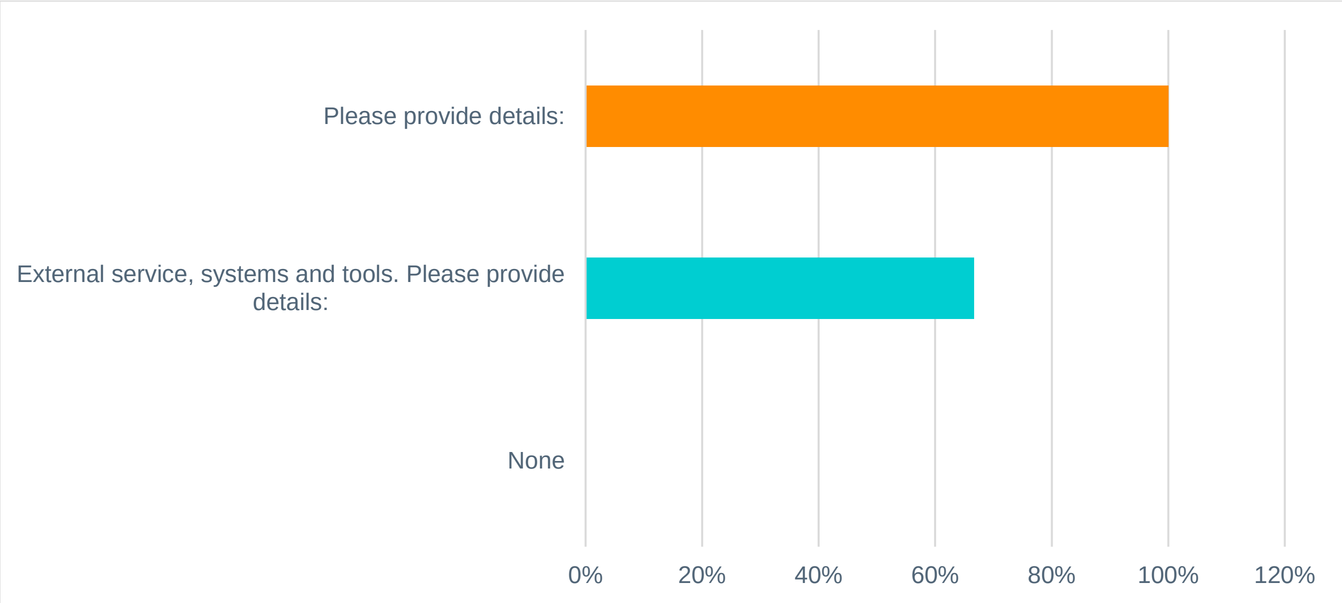
Not applicable as not started	25.00%	1
Unsure/ too soon to quantify	0.00%	0
Some evidence of value	50.00%	2
Demonstrable value	25.00%	1
Quantified and acknowledged value	0.00%	0
	Answered	4
	Skipped	1

Please provide details of the types of data technologies, systems and tools that your company provides? Digital Sensors (ability to automatically correct operational data): (Answered: 3, Skipped: 2)



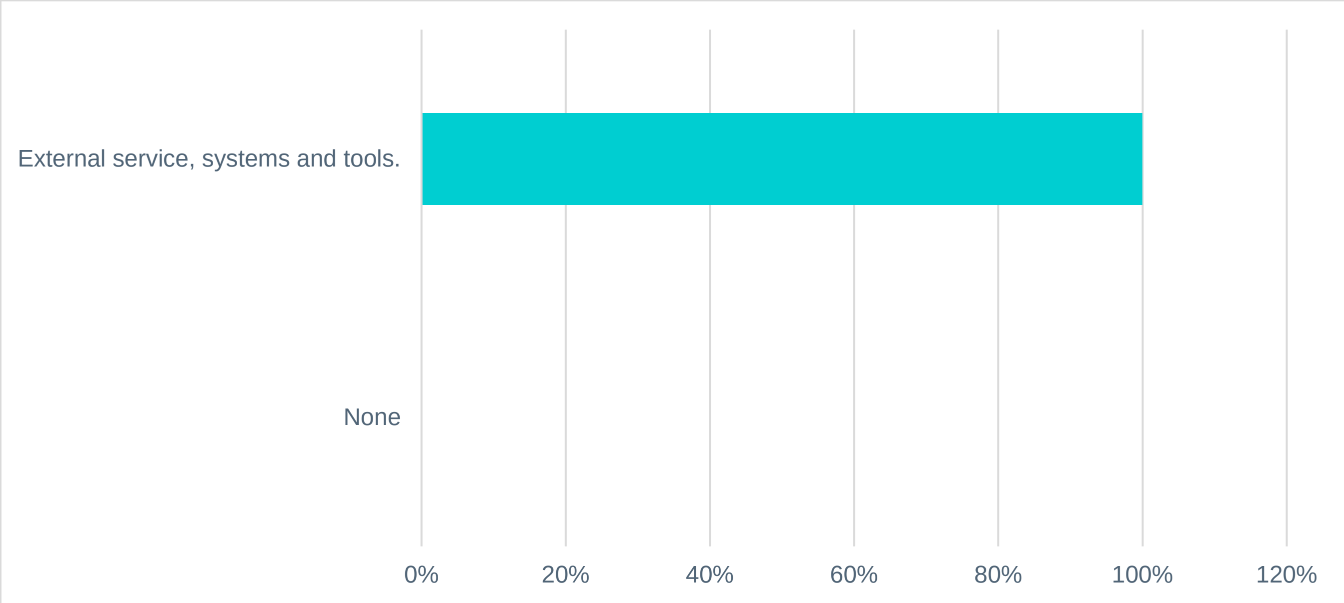
None	33.33%	1
External service, systems and tools. Please provide details:	33.33%	1
Please provide details:	66.67%	2
	Answered	3

Please provide details of the types of data technologies, systems and tools that your company provides? Data Transmission/Storage/Management (ability to send data onshore and offshore): (Answered: 3, Skipped: 2)



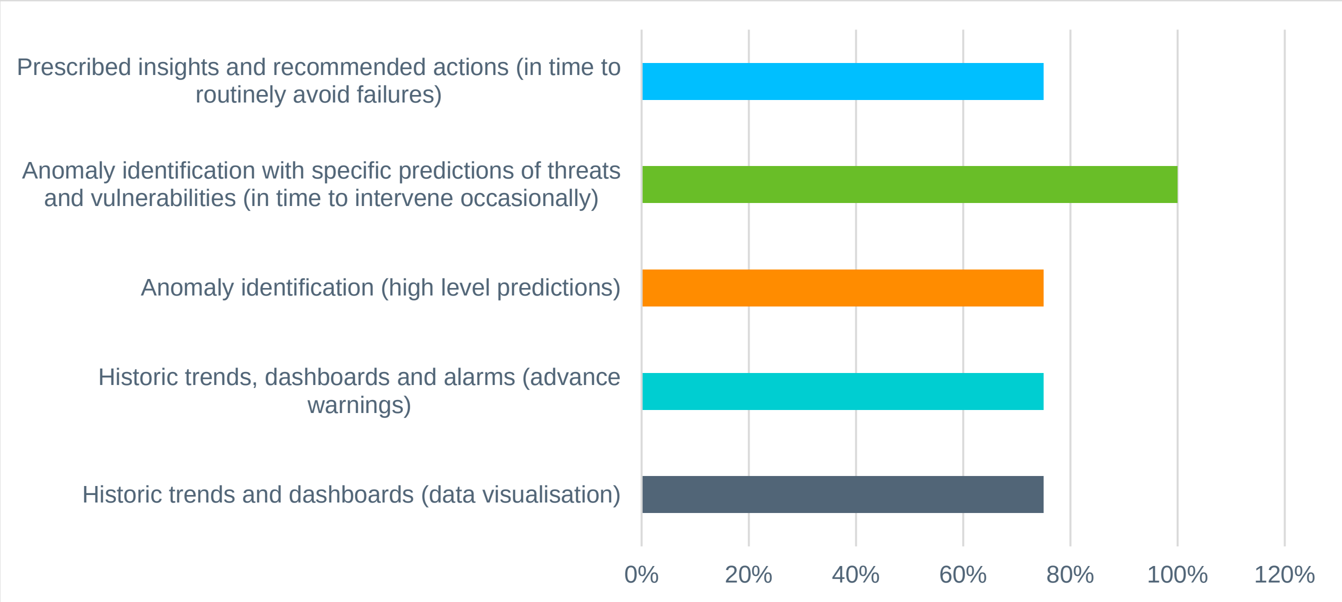
None	0%	0
External service, systems and tools. Please provide details:	67%	2
Please provide details:	100%	3
	Answered	3

Please provide details of the types of data technologies, systems and tools that your company provides? Data Analytics (ability to analyse operational data and make predictions): (Answered: 3, Skipped: 2)



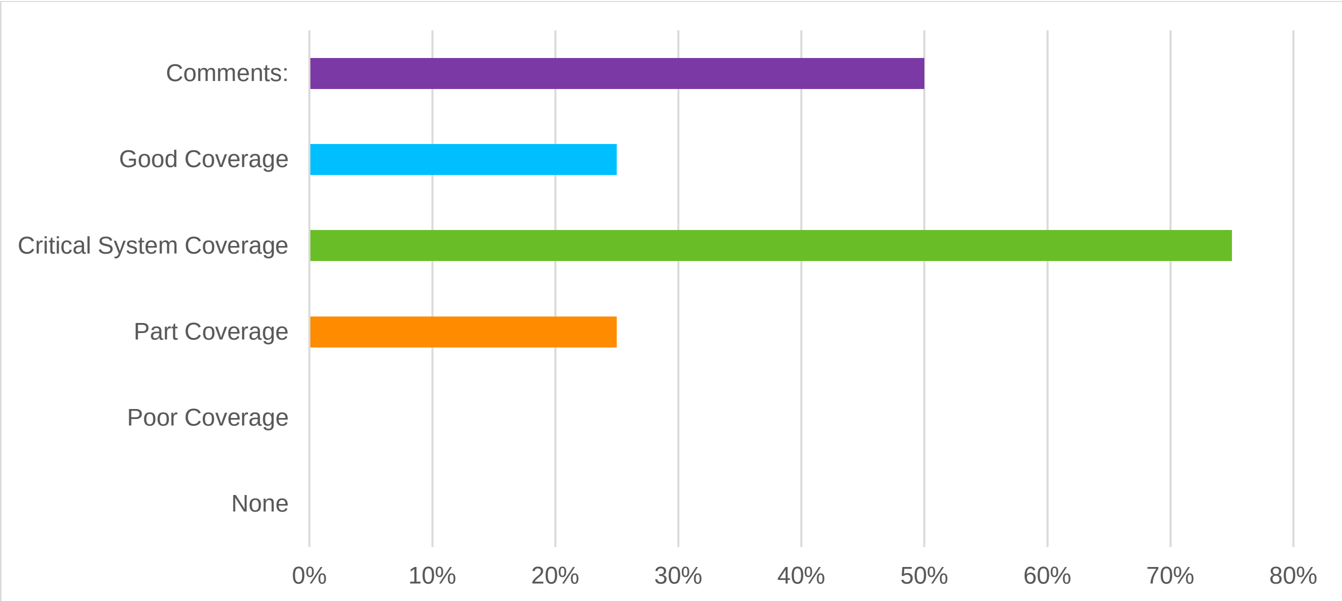
None	0.00%	0
External service, systems and tools.	100.00%	3
Please provide details:		4

In general, across the services, systems and tools in use in the industry, please indicate where you/your customers believe the level of capabilities is provided. (Answered: 4, Skipped: 1)



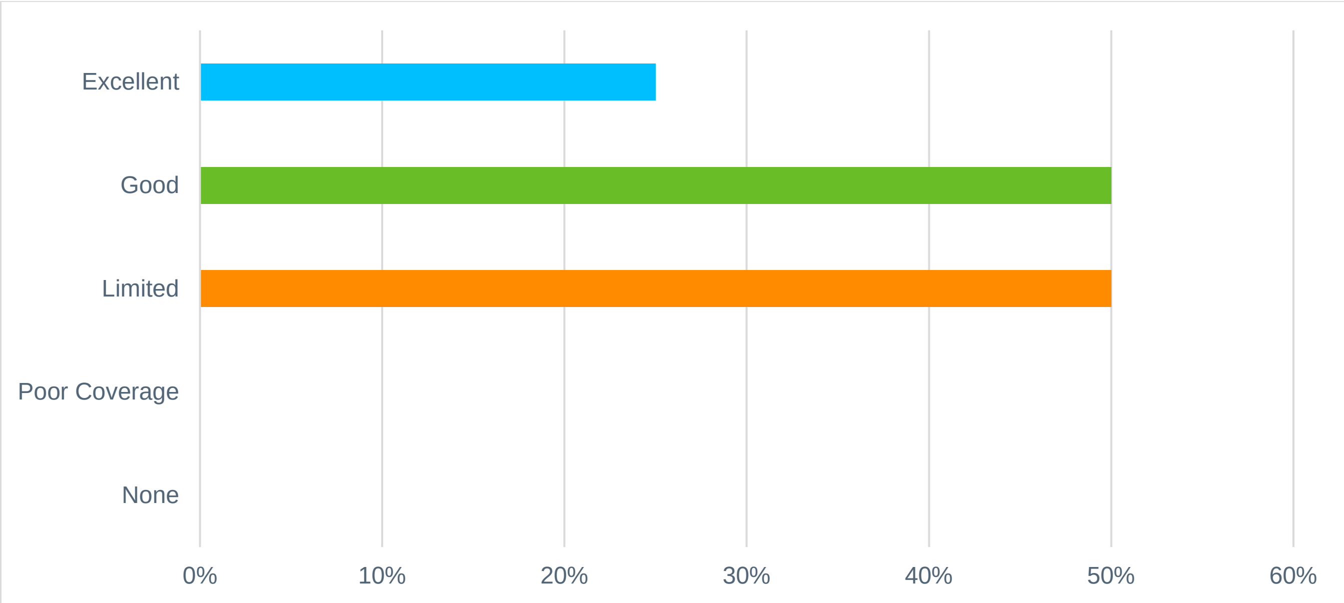
Historic trends and dashboards (data visualisation)	75%	3
Historic trends, dashboards and alarms (advance warnings)	75%	3
Anomaly identification (high level predictions)	75%	3
Anomaly identification with specific predictions of threats and vulnerabilities (in time to intervene occasionally)	100%	4
Prescribed insights and recommended actions (in time to routinely avoid failures)	75%	3
	Answered	4

In your opinion, please score where you believe you / your customers are in the Asset's capabilities for the deployment of data technologies to mitigate losses, improve uptime and prevent future failures. Please provide details of each technology employed. Digital Sensors (ability to automatically collect operational data) (Answered: 4, Skipped: 1)



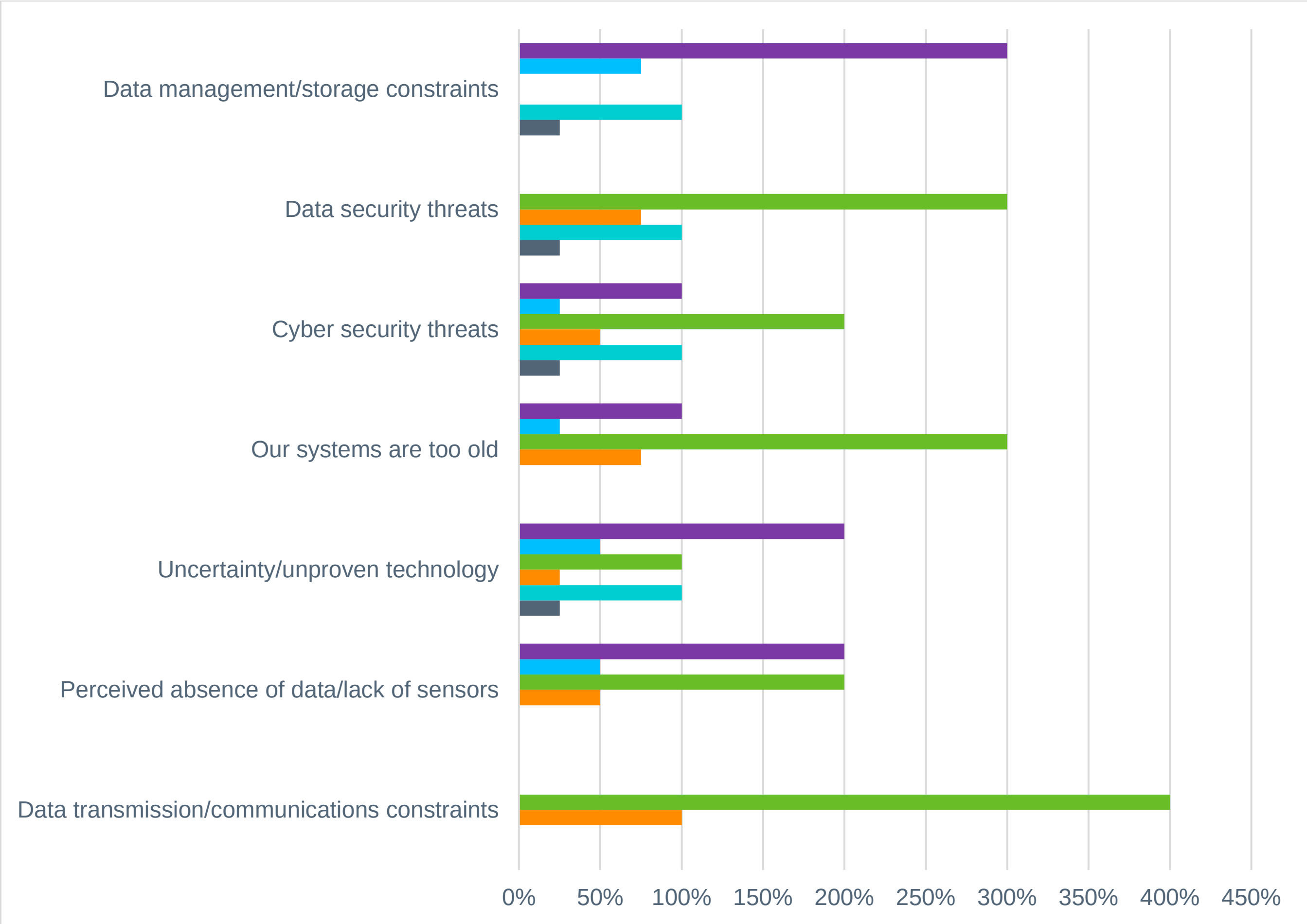
None	0%	0
Poor Coverage	0%	0
Part Coverage	25%	1
Critical System Coverage	75%	3
Good Coverage	25%	1
Comments:	50%	2
	Answered	4

In your opinion, please score where you believe you / your customers are in the Asset's capabilities for the deployment of data technologies to mitigate losses, improve uptime and prevent future failures. Please provide details of each technology employed. Data Transmission / Storage / Management (ability to send data onshore and store) (Answered: 4, Skipped: 1)



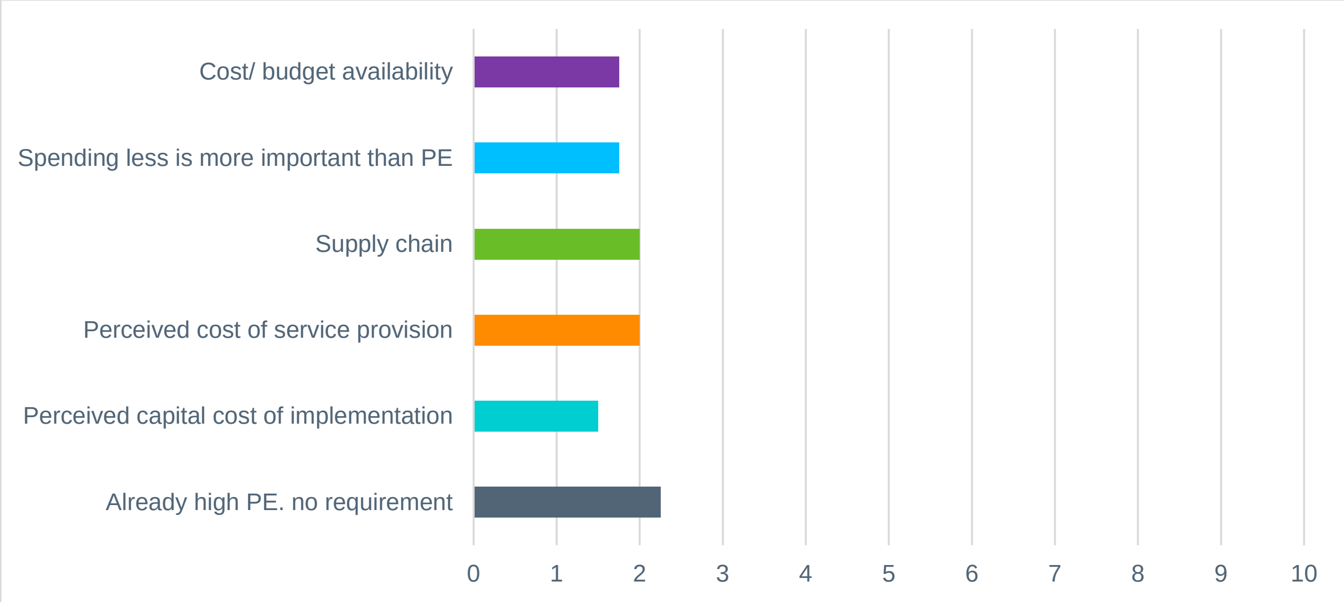
None	0%	0
Poor/limited	25%	1
Only for critical issues (please explain in comments below)	75%	3
Occasional/selective (please explain in comments below)	50%	2
Fully integrated into business process	0%	0

What would you consider to be the main barriers to adoption of a digital data led Production Efficiency improvement initiative in UKCS Assets? Please rank each element as follows:1. Barrier 2. Partial Barrier 3. No Barrier Commercial/Financial (Answered: 4, Skipped: 1)



	1		2		3		Total	Weighted Average
Data transmission/communications constraints	0%	0%	100%	400%	0%	0	4	2
Perceived absence of data/lack of sensors	0%	0%	50%	200%	50%	2	4	2.5
Uncertainty/unproven technology	25%	100%	25%	100%	50%	2	4	2.25
Our systems are too old	0%	0%	75%	300%	25%	1	4	2.25
Cyber security threats	25%	100%	50%	200%	25%	1	4	2
Data security threats	25%	100%	75%	300%	0%	0	4	1.75
Data management/storage constraints	25%	100%	0%	0%	75%	3	4	2.5
Comments/others:							1	

What would you consider to be the main barriers to adoption of a digital data led Production Efficiency improvement initiative in UKCS Assets? Please rank each element as follows:1. Barrier 2. Partial Barrier 3. No Barrier Commercial/Financial (Answered: 4, Skipped: 1)

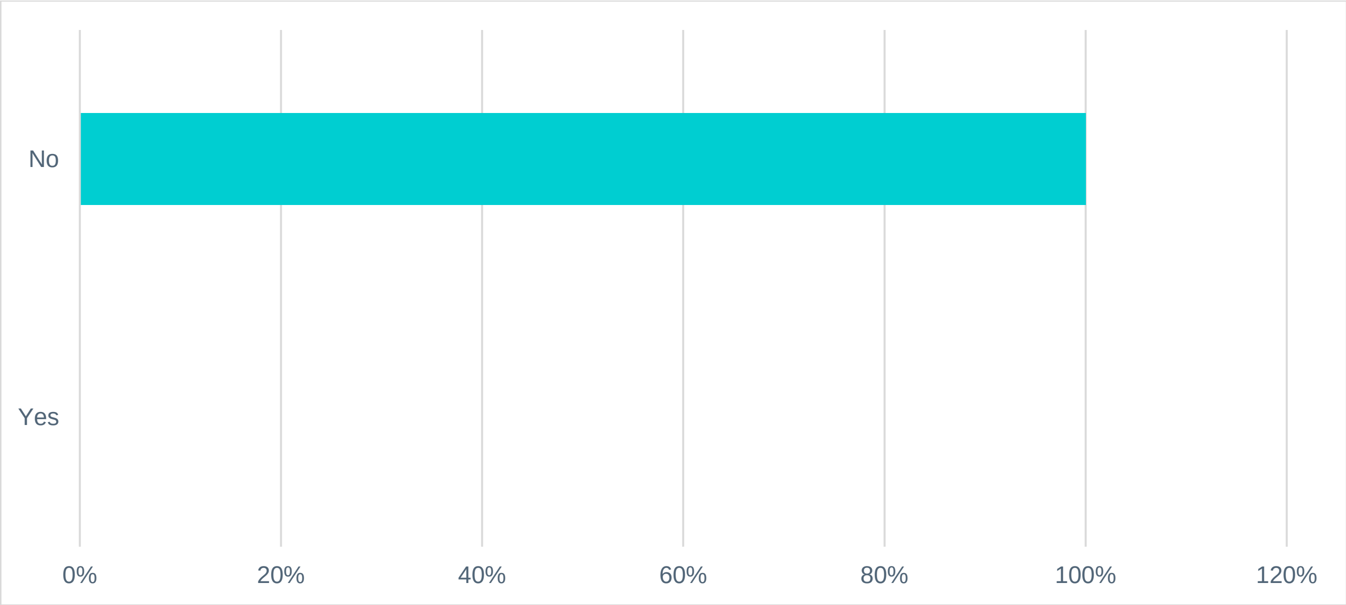


	1		2		3		Total	Weighted Average
Already high PE. no requirement	25%	100%	25%	100%	50%	2	4	2.25
Perceived capital cost of implementation	50%	200%	50%	200%	0%	0	4	1.5
Perceived cost of service provision	25%	100%	50%	200%	25%	1	4	2
Supply chain	25%	100%	50%	200%	25%	1	4	2
Spending less is more important than PE	50%	200%	25%	100%	25%	1	4	1.75
Cost/ budget availability	50%	200%	25%	100%	25%	1	4	1.75
Comments/others:							2	

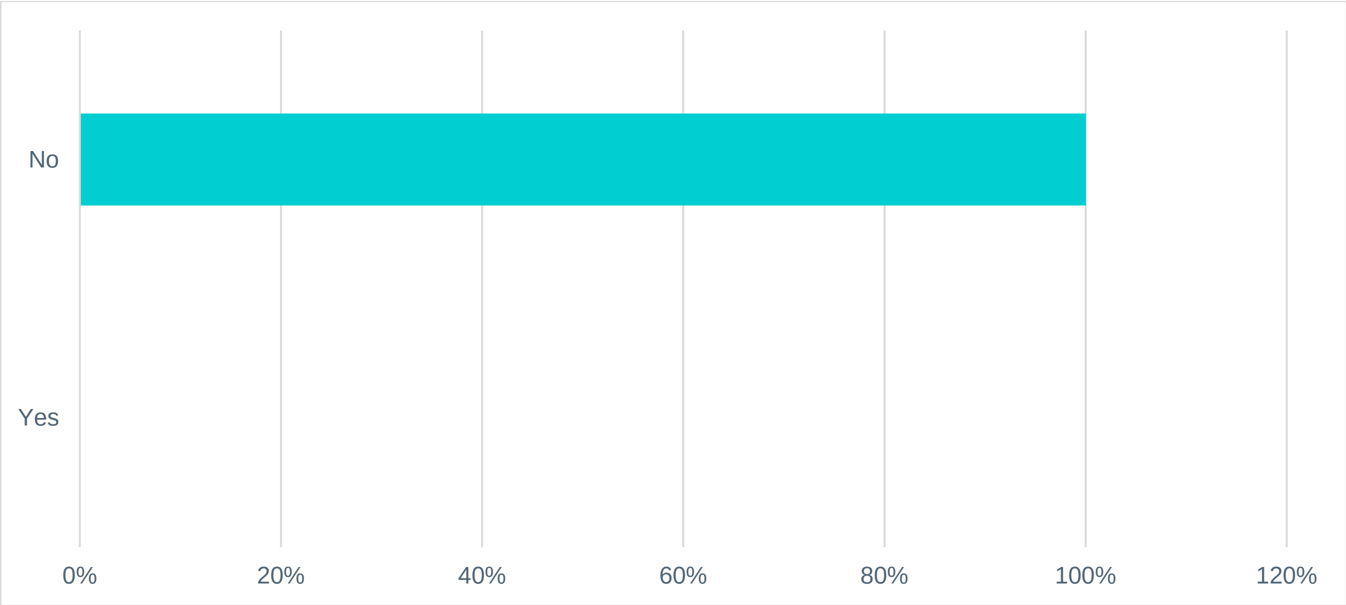
What would you consider to be the main barriers to adoption of a digital data led Production Efficiency improvement initiative in UKCS Assets? Please rank each element as follows: 1. Barrier 2. Partial Barrier 3. No Barrier Organisational (Answered: 4, Skipped: 1)

	1		2		3		Total	Weighted Average
Culture/People/Protectiveness	50%	200%	50%	200%	0%	0	4	1.5
It's more IT than operations/ lack of inter department/ asset collaboration	0%	0%	100%	400%	0%	0	4	2
Lack of knowledge/ understanding or confusion on what's possible	25%	100%	50%	200%	25%	1	4	2
Corporate initiatives/ conflicts driven from HQ (overseas)	0%	0%	25%	100%	75%	3	4	2.75
No time to look at new initiatives/perceived time to implement	0%	0%	100%	400%	0%	0	4	2
Lack of belief in offering	50%	200%	50%	200%	0%	0	4	1.5
Fear of being first/ early adopter/ personal risk	50%	200%	50%	200%	0%	0	4	1.5
Contractors dependency/ not our decision	0%	0%	100%	400%	0%	0	4	2
Too challenging for my company's resources	25%	100%	75%	300%	0%	0	4	1.75
Comments:							2	

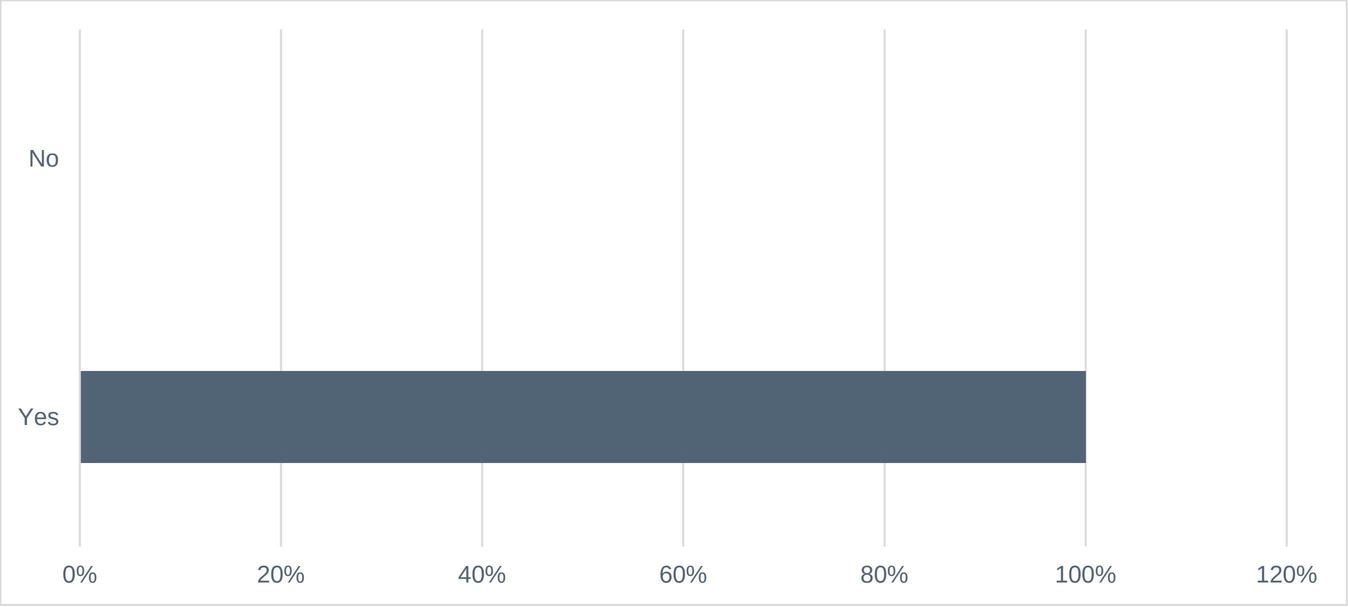
What is your policy/ willingness (subject to specific confidentiality agreements) to share operational data for enhanced capabilities? You would be willing to share your operational data with other operators for common learning potential? (Answered: 1, Skipped: 4)



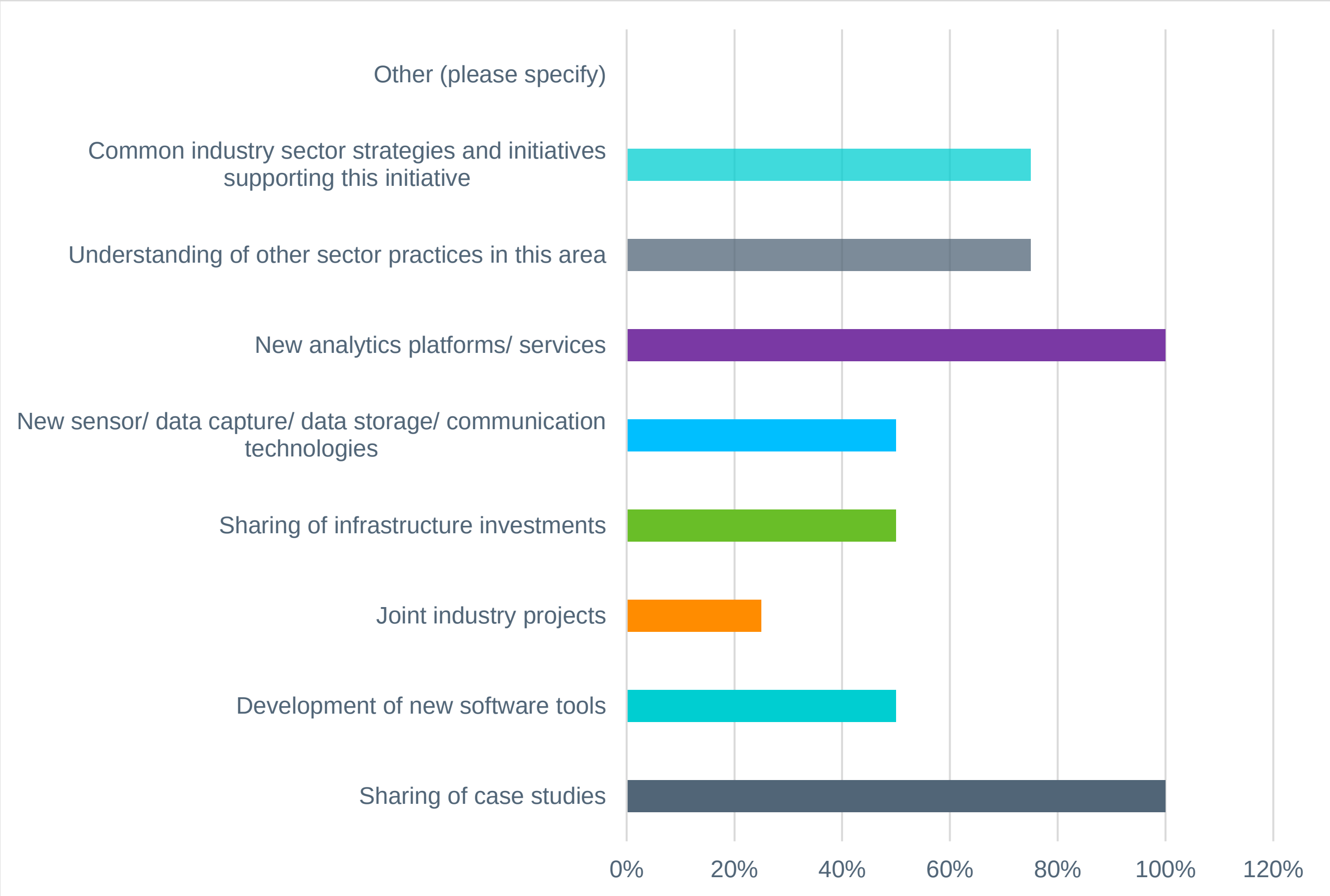
You would be willing to share your operational data along with specific problems with the supply chain? (Answered: 1, Skipped: 4)



If you selected no to either of the above, would you be willing to share if the operational data was anonymised? (Answered: 1, Skipped: 4)

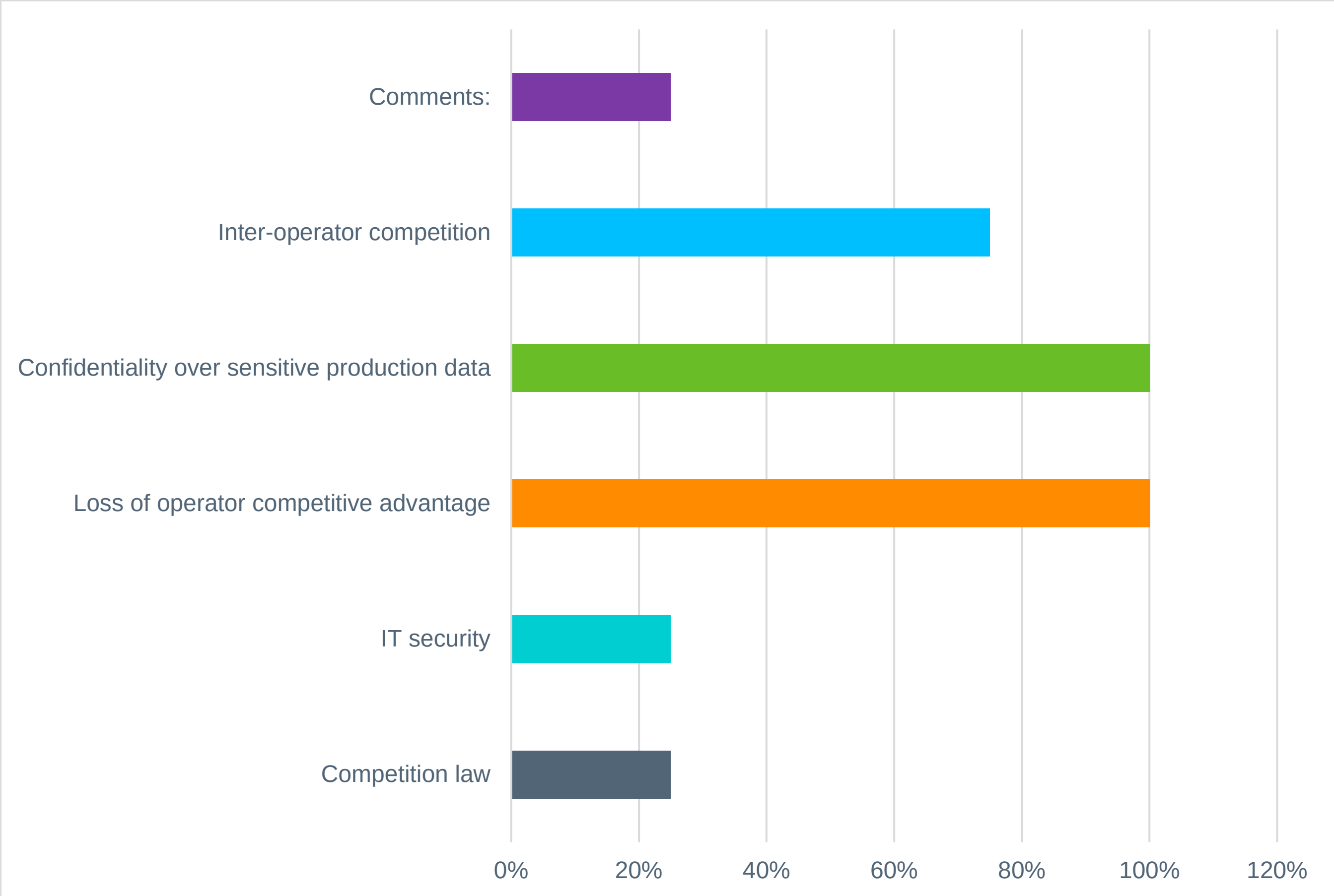


What would you find helpful if achieved through industry collaboration in this area? (Answered: 4, Skipped: 1)



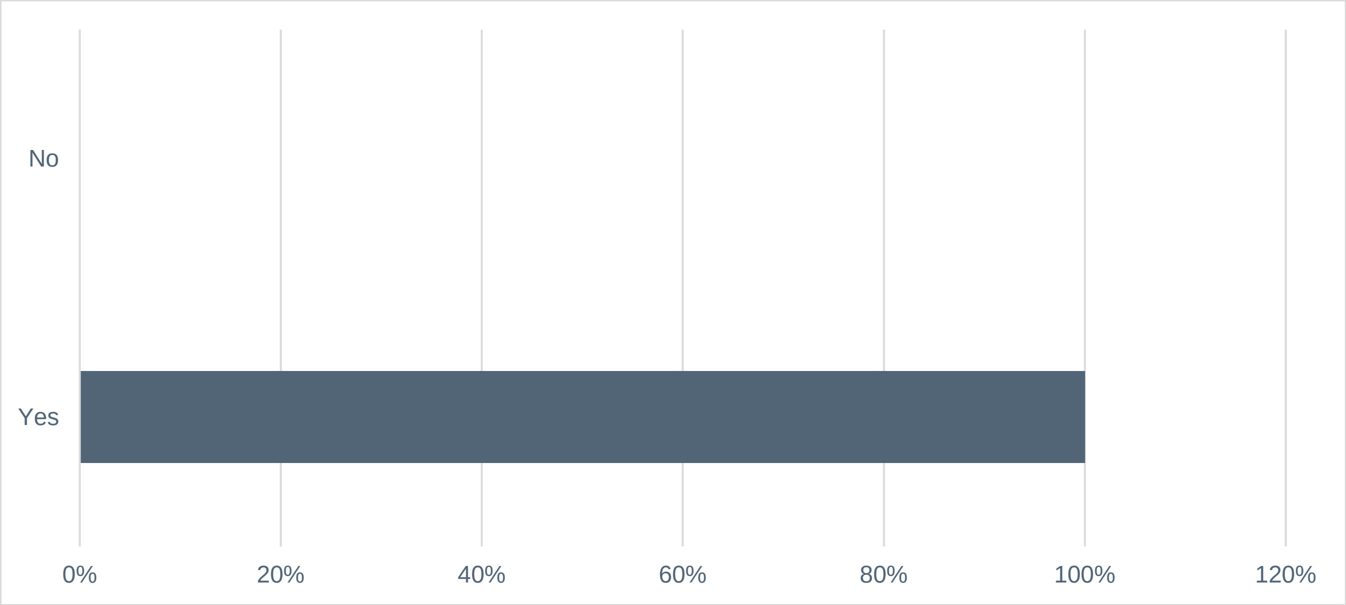
Answer Choices	Responses	
Sharing of case studies	100%	4
Development of new software tools	50%	2
Joint industry projects	25%	1
Sharing of infrastructure investments	50%	2
New sensor/ data capture/ data storage/ communication technologies	50%	2
New analytics platforms/ services	100%	4
Understanding of other sector practices in this area	75%	3
Common industry sector strategies and initiatives supporting this initiative	75%	3
Other (please specify)	0%	0
	Answered	4

Do you see any potential challenges in the collaborative development of a digital data led Production Efficiency improvement initiative? (Answered: 4, Skipped: 1)

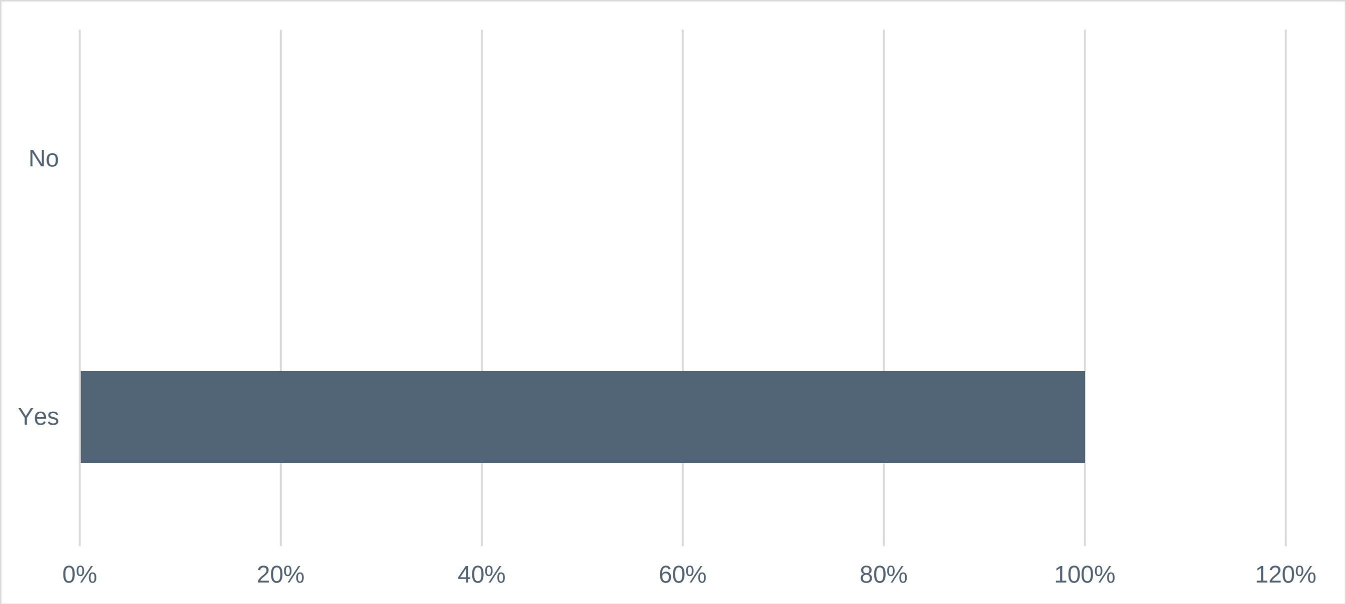


Answer Choices	Responses	
Competition law	25%	1
IT security	25%	1
Loss of operator competitive advantage	100%	4
Confidentiality over sensitive production data	100%	4
Inter-operator competition	75%	3
Comments:	25%	1
	Answered	4

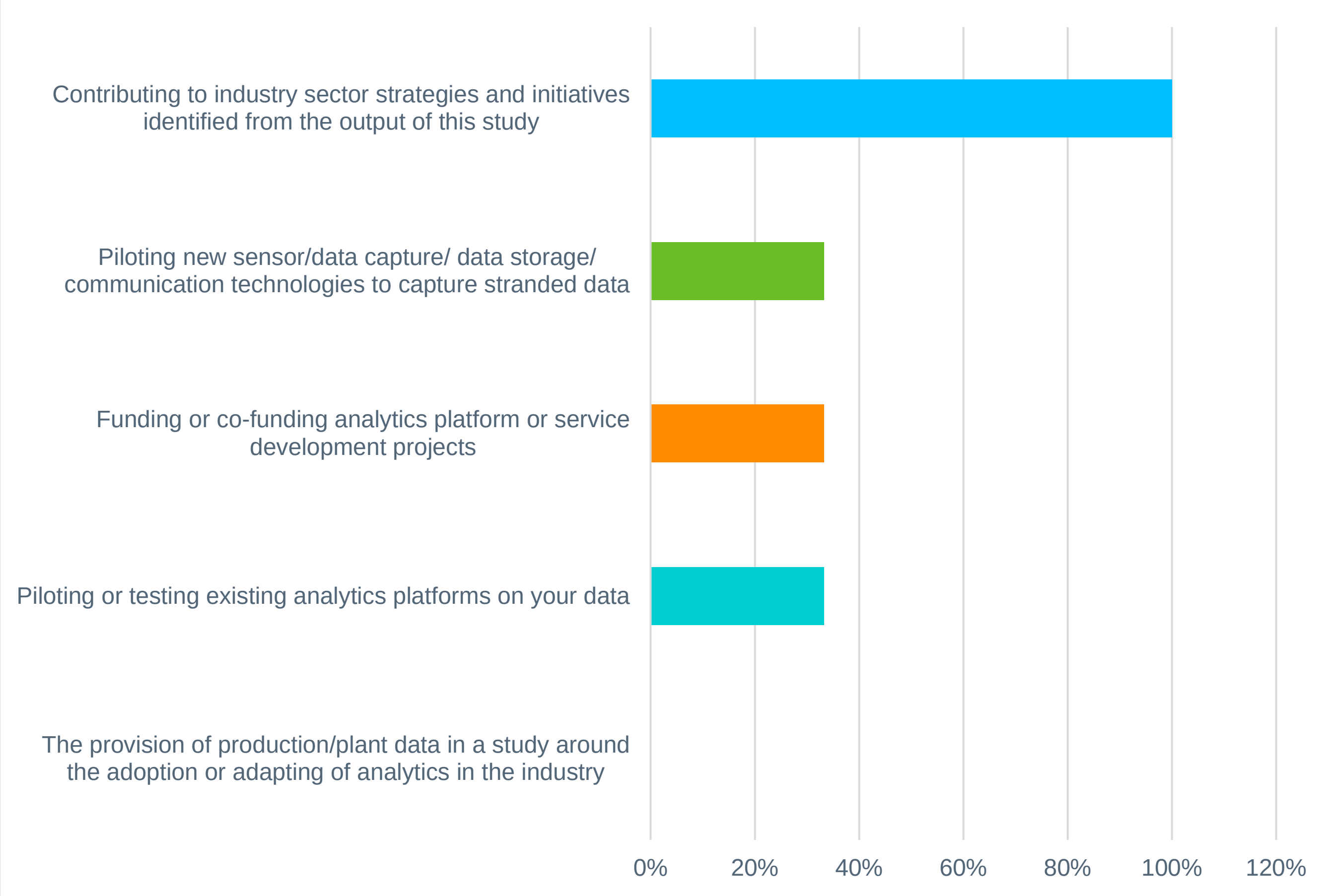
Do you have case studies which demonstrate where an improvement in production efficiency has been made through digital and data technologies? (Answered: 4, Skipped: 1)



If you answered yes to above, would you be willing to share these with industry? (Answered: 4, Skipped: 1)



Would you be willing to participate in any of the following? (Answered: 3, Skipped: 2)



Answer Choices	Responses	
The provision of production/plant data in a study around the adoption or adapting of analytics in the industry	0%	0
Piloting or testing existing analytics platforms on your data	33%	1
Funding or co-funding analytics platform or service development projects	33%	1
Piloting new sensor/data capture/ data storage/ communication technologies to capture stranded data	33%	1
Contributing to industry sector strategies and initiatives identified from the output of this study	100%	3
	Answered	3

10. Glossary of Terms

ASTF .... Asset Stewardship Task Force

boe .... Barrels of Oil Equivalent

ITF .... Industry Technology Facilitator

MER .... Maximise Economic Recovery

NPT .... Non-Productive Time

OGA .... Oil and Gas Authority

PE .... Production Efficiency

PETF .... Production Efficiency Task Force

SME... Small to Medium Enterprise

TLB.. Technology Leadership Board

UKCS .... United Kingdom Continental Shelf