PSA Webinar: Pipelines & Subsea – Presentation of industry reports on integrity management

DNV GL Report 2020-1137 ‘How digital tools and solutions can improve Subsea Integrity Management ‘

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Agenda

Brief intro to DNV report 2020-1137 ‘How digital tools and solutions can improve Subsea Integrity Management ‘

- Background, objective & SoW
- Highlights Sec.3 to 5
- Challenges, Opportunities & main observations
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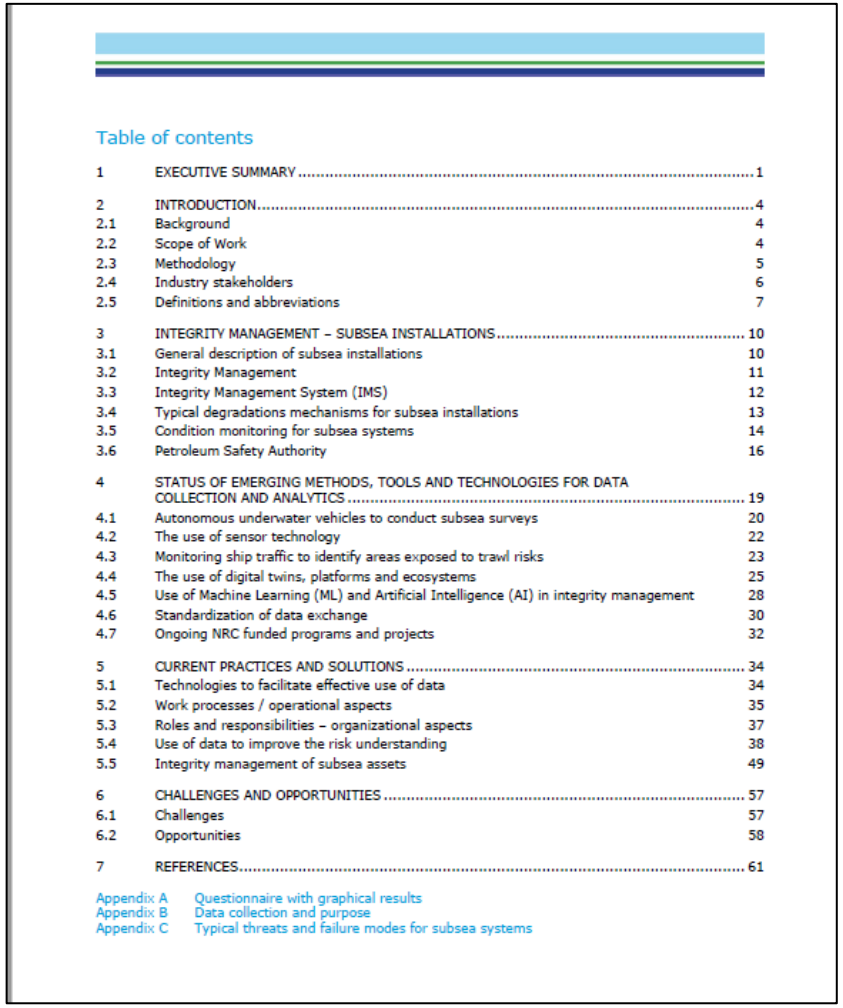

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DNV·GL

INTEGRITY MANAGEMENT AND CONDITION MONITORING OF PIPELINES AND SUBSEA EQUIPMENT (2020/1022)

2020/1022: How digital tools and solutions can improve Subsea Integrity Management

Petroleumstilsynet

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Background

Understanding the condition of all elements of a subsea system is vital to ensuring safe operations and production and this is obtained by managing the integrity of the subsea assets.

There is a large number of data systems and sources that can be utilized to reach this goal and current technologies allow the industry to link different data sources together to increase accessibility to the data.

Data management and use of data, facilitated by digital tools and solutions, can bring various benefits to day-to-day operations, such as increased efficiency, optimization, cost reduction and safety.

For integrity management specifically, industry data, historical data and real-time data allow operators to improve maintenance and inspection regimes if implemented and utilized appropriately.

The challenge is however multiple, such as to which level the integration of such sources is implemented in the operator's organisations and how to manage the single source of truth over the entire life span

Objective & Scope of Work

Objective:

- To establish a status of available information, knowledge and tools that can provide better integrity management of subsea systems. Such tools can give a better overview of the state of the system, reduce the risk of incidents and provide a more predictable operation of the facilities.
- Highlight areas where knowledge and information are not fully systematized and utilized for continuous improvement and risk reduction.

✓ Current Status

✓ Key Challenges

✓ Opportunities

Scope of Work:

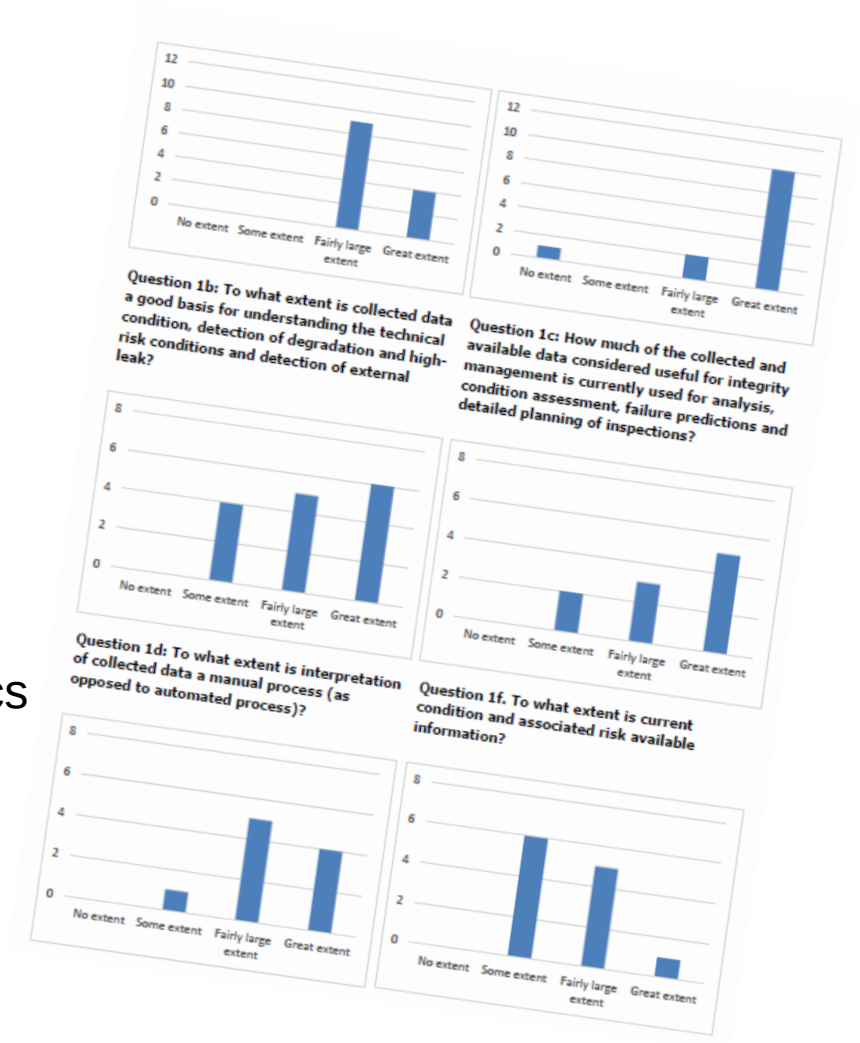
- How opportunities that currently lie in digital solutions are utilized in order to ensure integrity
- Identification of opportunities that are not usually being exploited today in relation to analysis of data, whether it comes from sensors, production data, inspection or monitoring data etc.

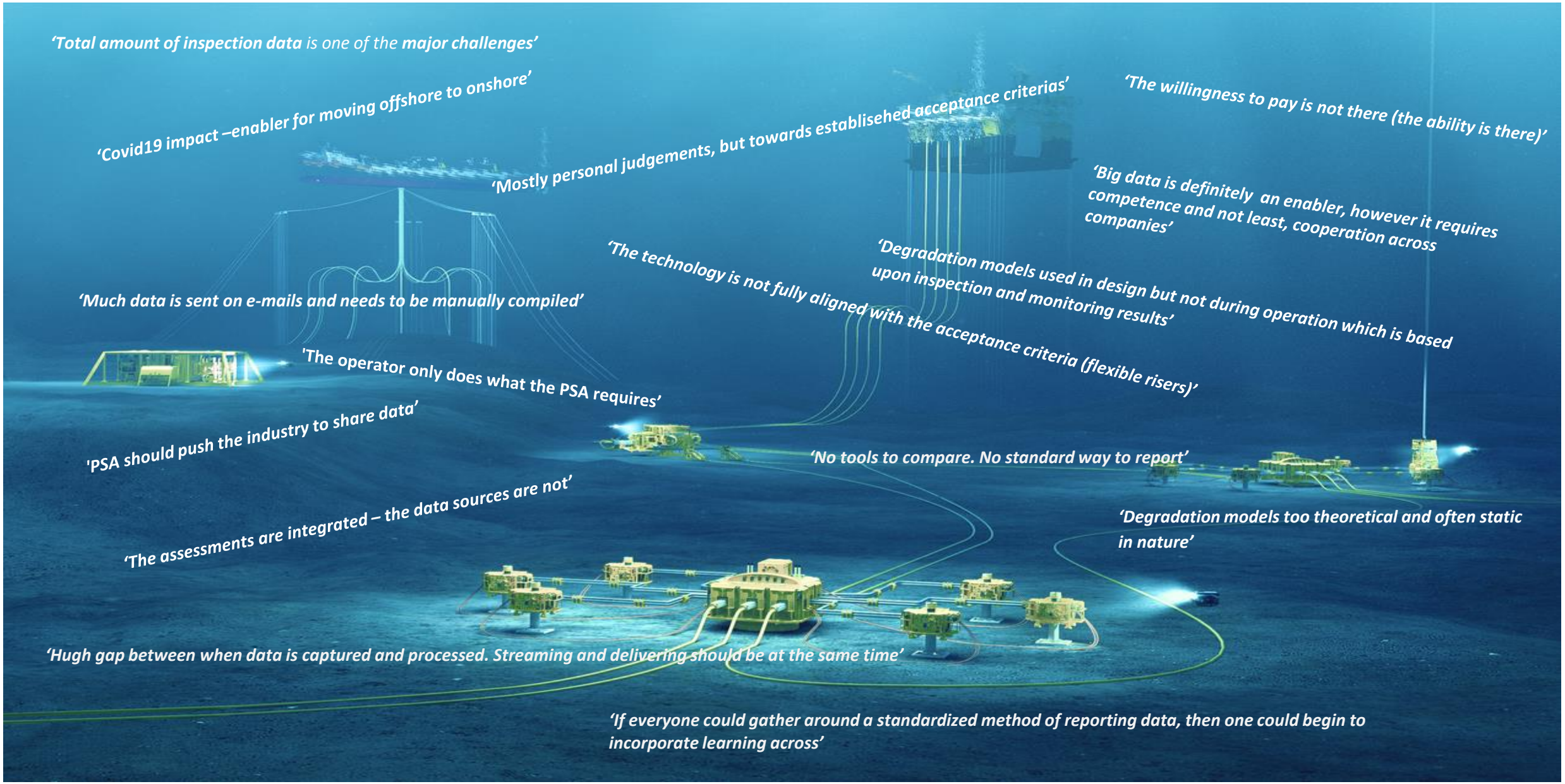
Information gathering by interviews, literature search and experience

Operators	Aker BP, ConocoPhillips Norge, Equinor Energy, Gassco, Neptune Energy Norge, Norske Shell, Wintershall DEA
Engineering and Service companies	TechnipFMC, Aker Solutions; 4Subsea
Survey companies	Oceaneering, DeepOcean
In-Line Inspection companies	NDT-Global*; Rosen*
*) No interview, only response to questionnaire	

1. Current integrity management practice; data, interpretation, knowledge and tools
2. Data quality and availability
3. Degradation models and predictive power
4. Digitalization and new technology
5. Industry collaboration and research
6. Main Challenges and Opportunities
7. Lessons learned / case

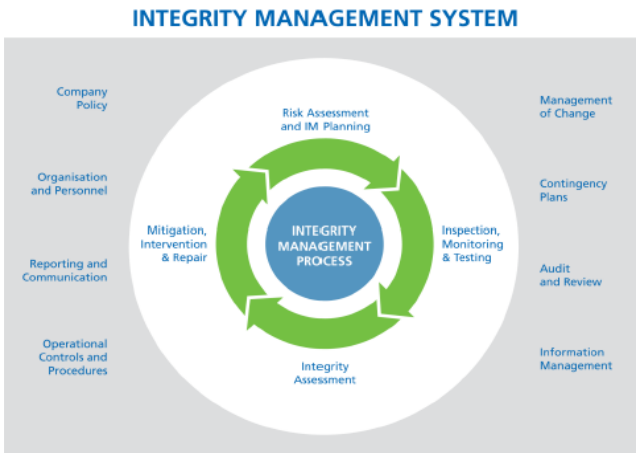
Questionnaire & Graphics




'Total amount of inspection data is one of the major challenges'
'Covid19 impact –enabler for moving offshore to onshore'
'Mostly personal judgements, but towards establisehed acceptance criterias'
'The willingness to pay is not there (the ability is there)'
'Big data is definitely an enabler, however it requires competence and not least, cooperation across companies'
'Much data is sent on e-mails and needs to be manually compiled'
'The technology is not fully aligned with the acceptance criteria (flexible risers)'
'Degradation models used in design but not during operation which is based upon inspection and monitoring results'
'The operator only does what the PSA requires'
'PSA should push the industry to share data'
'No tools to compare. No standard way to report'
'The assessments are integrated – the data sources are not'
'Degradation models too theoretical and often static in nature'
'Hugh gap between when data is captured and processed. Streaming and delivering should be at the same time'
'If everyone could gather around a standardized method of reporting data, then one could begin to incorporate learning across'

Sec.3: Integrity Management - Subsea Installations

- General description of;
  - subsea installations
  - subsea integrity management
- Typical degradation mechanisms
- Condition monitoring of subsea systems
- **Petroleum Safety Authority regulations**



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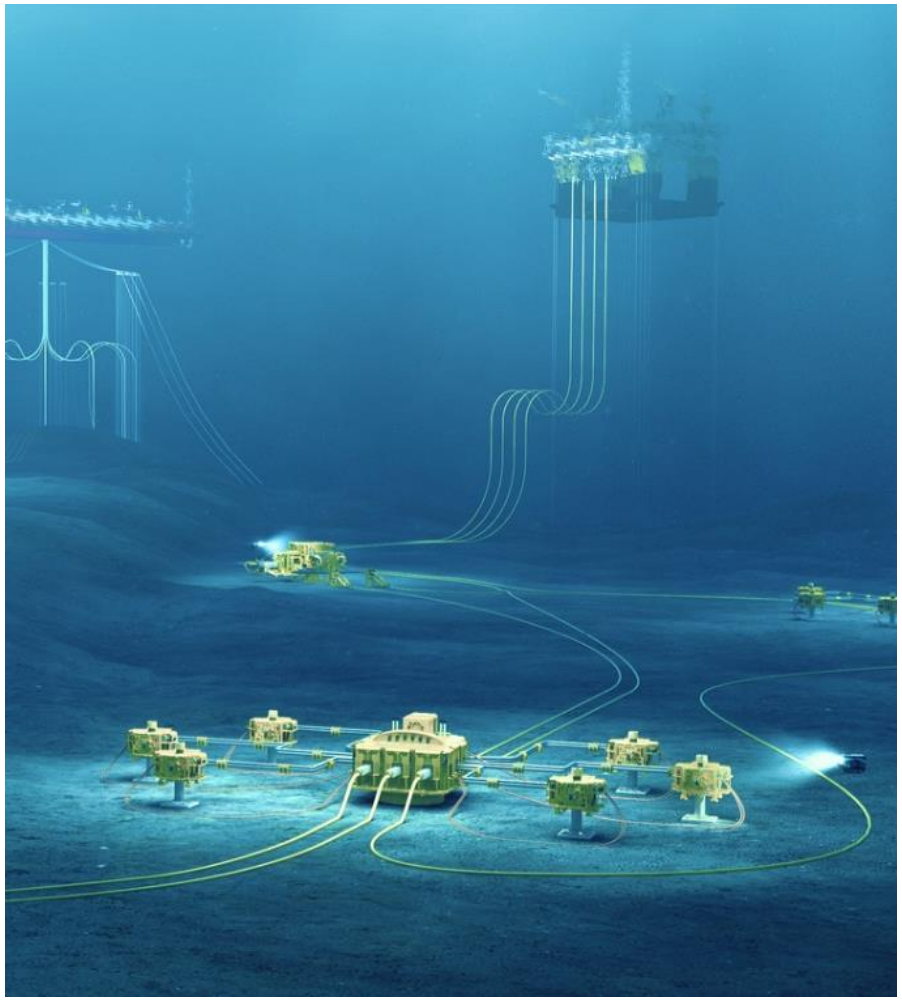


Sec.4: Status of emerging methods, tools & technologies for data collection & analytics

The most relevant described in detail

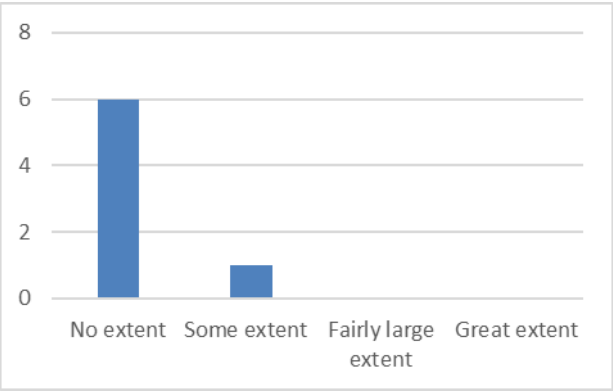
- Autonomous Underwater Vehicles (AUVs) to conduct subsea surveys
- Sensor technology
- Monitoring ship traffic to identify areas exposed to trawl risk
- The use of digital twins, platforms and ecosystems
- Standardisation of data exchange
- The use of Artificial Intelligence (AI) / Machine Learning (ML)

Sec.4 The two main application areas of ML in subsea integrity management

Possible ML applications	Examples
Automatic anomaly detection	• ILI inspections • subsea surveys • flexible riser annulus monitoring • leak detection
Prediction	• condition assessment / corrosion failures in pipelines /17/ • fatigue failures in flexible risers /21/

Typical subsea integrity challenges:

- Detect anomalies and predict failure
- Finding complex relationships in a vast amount of data, multiple systems and sources
- Long processing times of ILI and survey data

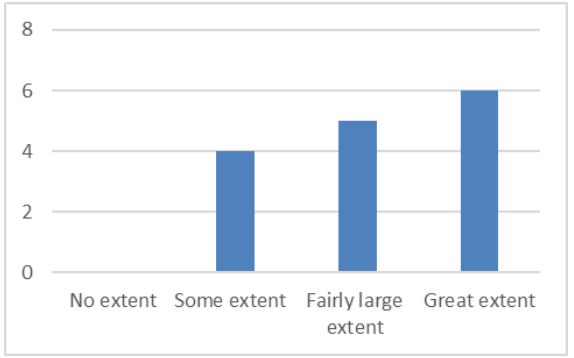


To what extent has Artificial Intelligence (AI) / Machine Learning (ML) been applied for maintenance / testing / inspection and e.g. predicting time to failure or analysing root causes?

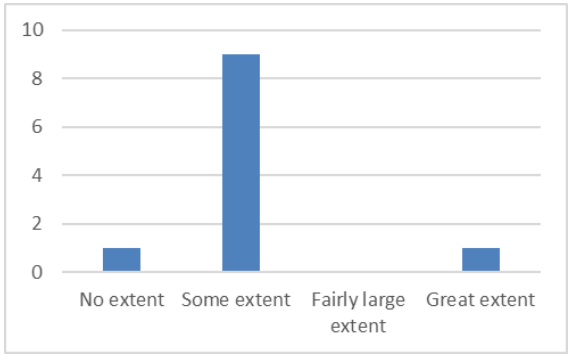
Sec.5 Current Practices & Solutions

- **Technologies to facilitate effective use of data**
  - Collection and transfer of data from point of collection to user
  - Asset Information Model to enable integration and contextualisation of data
  - Data integration platforms to enable sharing and use of data
  - Automatic detection and categorisation of degradation and anomalies
  - Integrity management tools
- **Work processes**
  - What, how, where and when; automation and near real-time assessment
  - Availability and presentation of data, information, condition and risk
  - Sharing of data; improvement and learning
- **Roles and responsibilities**
  - In own organisation; new competencies
  - Interaction and use of subject matter experts between Operators, engineering companies and service providers

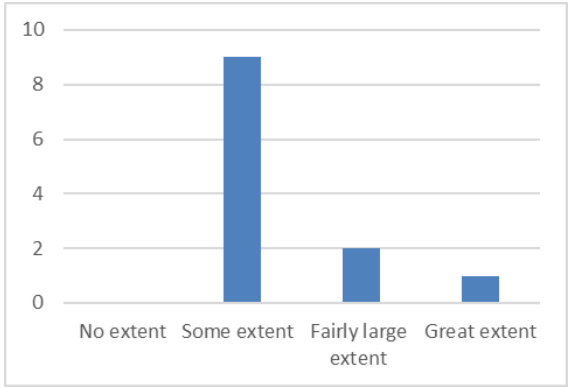
To what extent is interpretation of collected data a manual process?



To what extent are degradation models, algorithms and automatic assessment tools used?



To what extent are the data sources and tools / models integrated to ensure an efficient use?



Sec.5 Current Practices & Solutions

Use of data to improve the risk understanding

In the context of subsea integrity management and associated risk, it is discussed how to go from data to making informed decisions to ensure that loss of containment does not occur. The following main topics are highlighted in report:

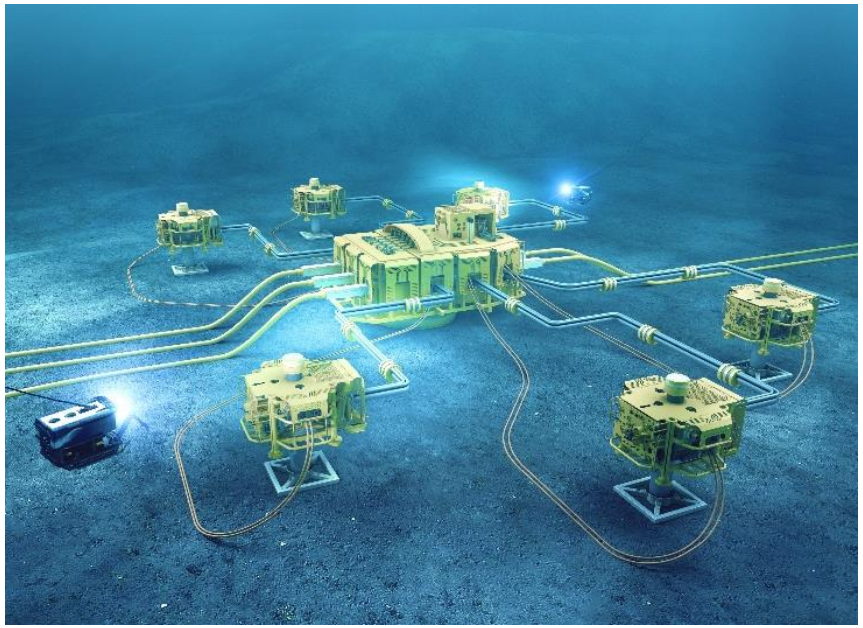
- what data are relevant and how to collect them
- how to integrate the data and why
- how to interpret the data to understand degradation, condition and risk
- how to present technical condition and risk

Integrity management of subsea assets

Describe how data collection, integration and interpretation is currently applied within the different types of subsea assets, and how this is typically integrated across the subsea assets to support a holistic view on subsea integrity management. The subsea assets are split in Risers, Pipelines and Subsea Production Systems

Sec.5 Current Practices & Solutions

- The reported non-conformances and improvement needs from PSA supervisions in the time period from January 2018 to date, were reviewed in order to summarise reported non-conformities and improvement points for use of data related to improved IM. Main findings covers;
  - Leak detection (operationalization and acceptance criteria…)
  - Integrity management (use of data, instrumentation, performance standards…)
  - Flexible risers and jumpers (prediction of degradation, operational limitations…)
  - Pipelines (corrosion modelling, monitoring…)



- The regulations, in several places, uses the term *(…) at all times (…)*. There seems to be potential in going from manual, regular review of data, to a more automatic, continuous processing of data, to better understand technical condition and associated risk *at all times*.

Sec.6 Challenges

Availability of information; Updated information to show the current technical condition and associated risk is only intermittently available to stakeholders (e.g. management, partners, regulator).

- The data is typically collected, assessed and presented/reported at certain milestones.
- Data to inform about technical condition and associated risks are typically stored in a number of different systems, and partly on servers with limited access (i.e. lack of integrated systems).
- Integration and interpretation of data is highly dependent on manual assessments from dedicated subject matter experts.

Unclear business case; It is a challenge to demonstrate a sound business case for extensive initiatives to improve data collection and integration.

- Technology development and qualification have a high cost.
- Economic benefits from improved integrity management and barrier management is difficult to quantify, and the value of having subsea engineers and subject matter experts collecting and assessing the data is by some, perceived to be difficult to replace.
- Even though monitoring data are trusted, they are not always used to adjust inspection intervals, hence, not used to potentially reduce cost associated with offshore operations.

Sec.6 Challenges

Leak detection; Data to inform about small or diffuse hydrocarbon leaks, and strategies for leak detection, are considered to be an area of potential improvement.

- Monitoring technologies for detection of small or diffuse leaks, typically from subsea connectors and bolted connections, need to be better understood and qualified to provide reliable detection data.
- Leak detection strategies and criteria need to be improved to provide reliable detection and response to small or diffuse subsea leaks.

Integrity management of flexible risers; Data to inform about the development of credible failure modes in flexible risers and jumpers should be improved.

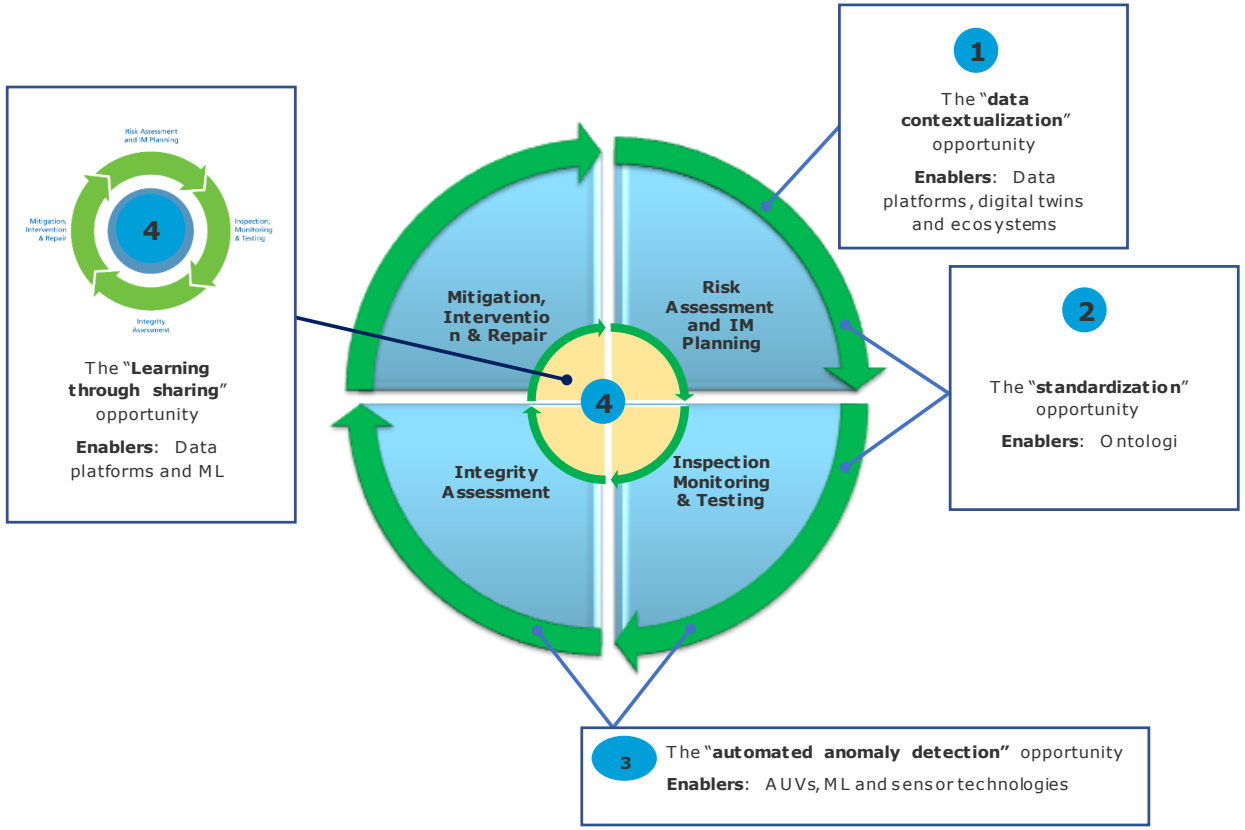
- Inspection and monitoring technologies to reliably confirm the condition and predict the degradation of the metallic and non-metallic layers in flexible pipes, and particularly at hot spots (terminations, bend restrictor, bend stiffener/sag/hog, touch-down point) still needs to be improved in order to increase the understanding and reduce the uncertainty.
- Integrity management strategies and criteria need to be improved and operationalized to provide reliable prevention (e.g. operational controls) and detection of degradation and failure modes under development.

Sec. 6 Opportunities

The four key opportunities enabled by emerging technologies, and how they may contribute to improved integrity management.

Key opportunities:

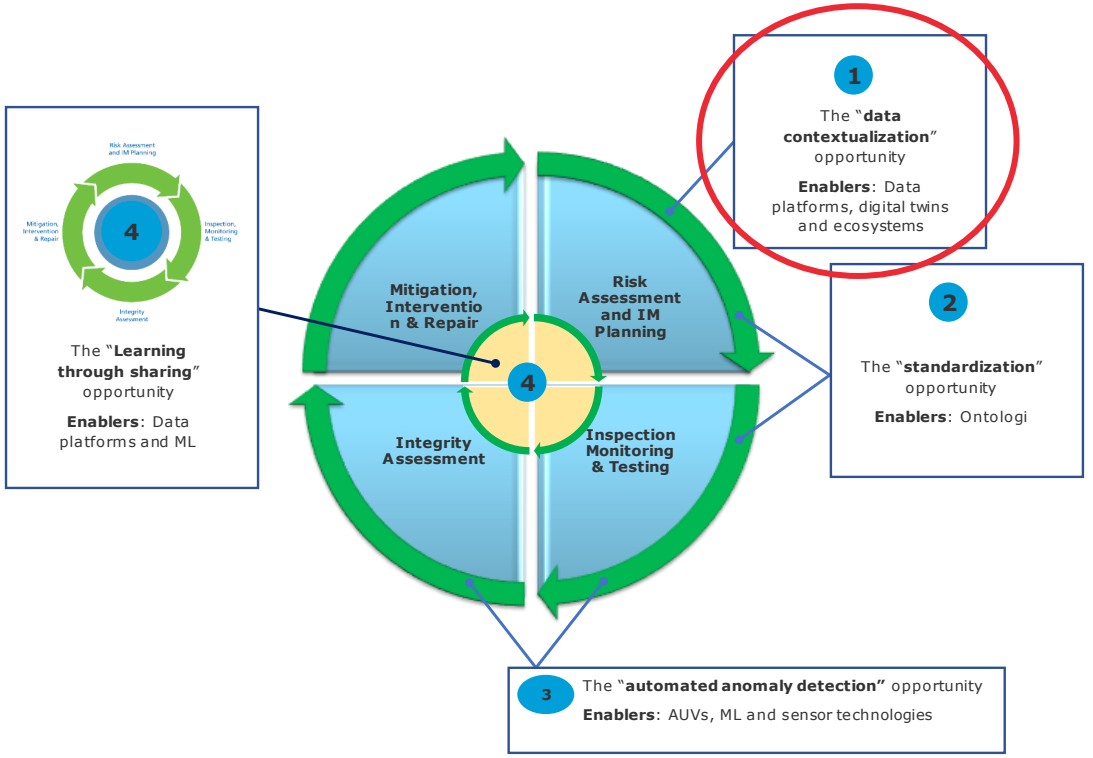
- Data contextualization
- Standardization
- Automated anomaly detection
- Learning through sharing



Sec. 6 Opportunities

Data contextualization

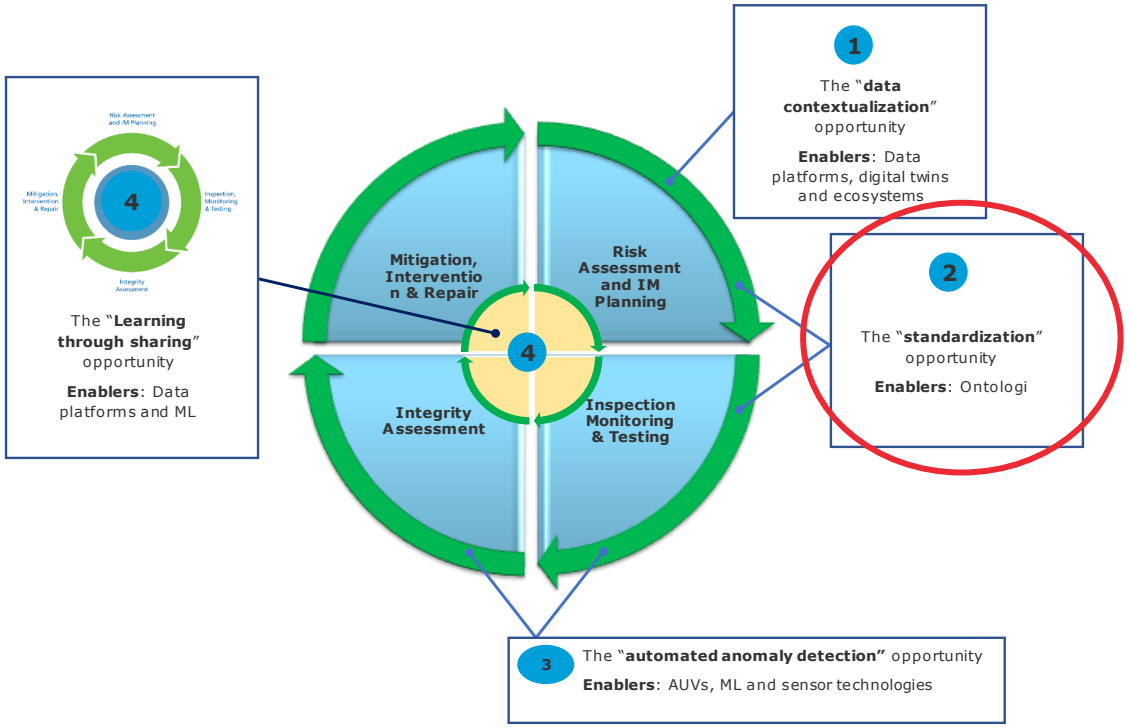
- There are no technical showstoppers for combining data into integrated systems to enable dynamic integrity management and risk management.
- Enablers include cloud-based storage, increased computational power, data platforms, digital twins and ecosystems, as well as standardisation.
- It is, however, costly and time consuming, and takes management dedication and stamina to achieve.



Opportunities

Standardization

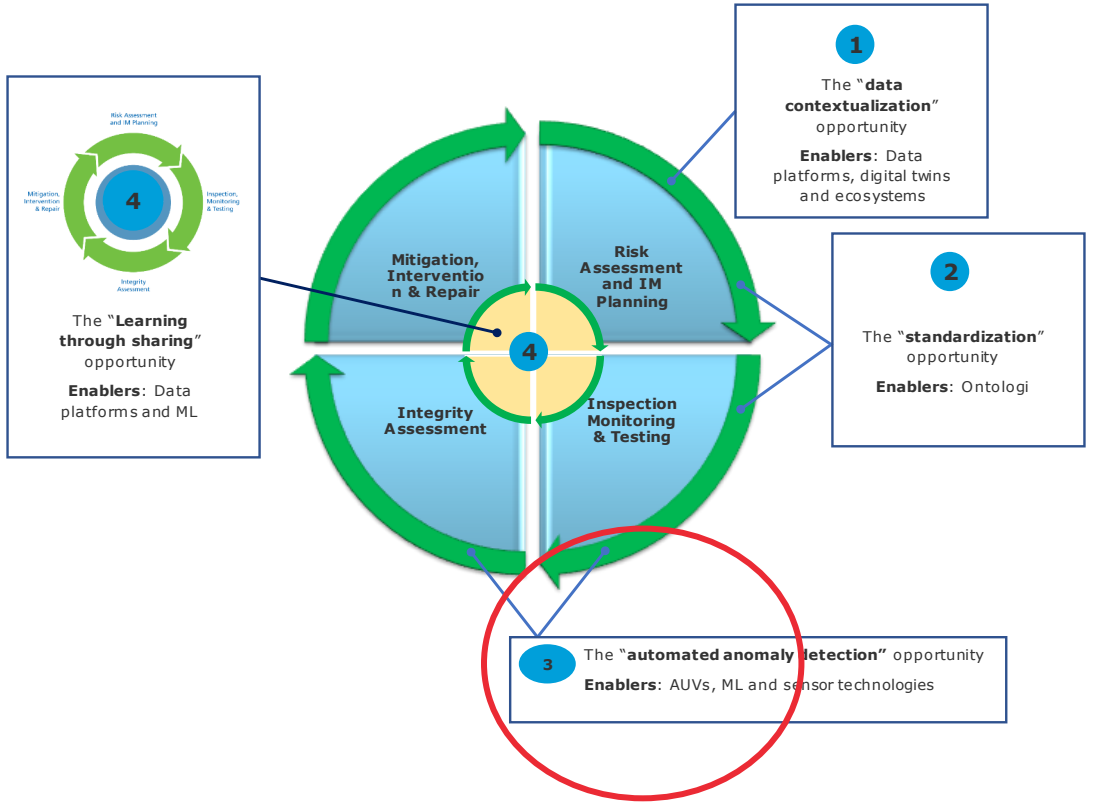
- Standard ontologies for semantic asset information models and standardised data formats for easier exchange, integration and comparison / trending of data are considered significant enablers for developing models and automation, as well as to enable sharing of data.
- In the long run standardisation will bring big benefits, in the short term it might be perceived to represent a cost.
- The most prevalent standardisation need identified in this study is to standardize on in-line inspection (ILI) and subsea survey data formats.



Sec. 6 Opportunities

Automated anomaly detection

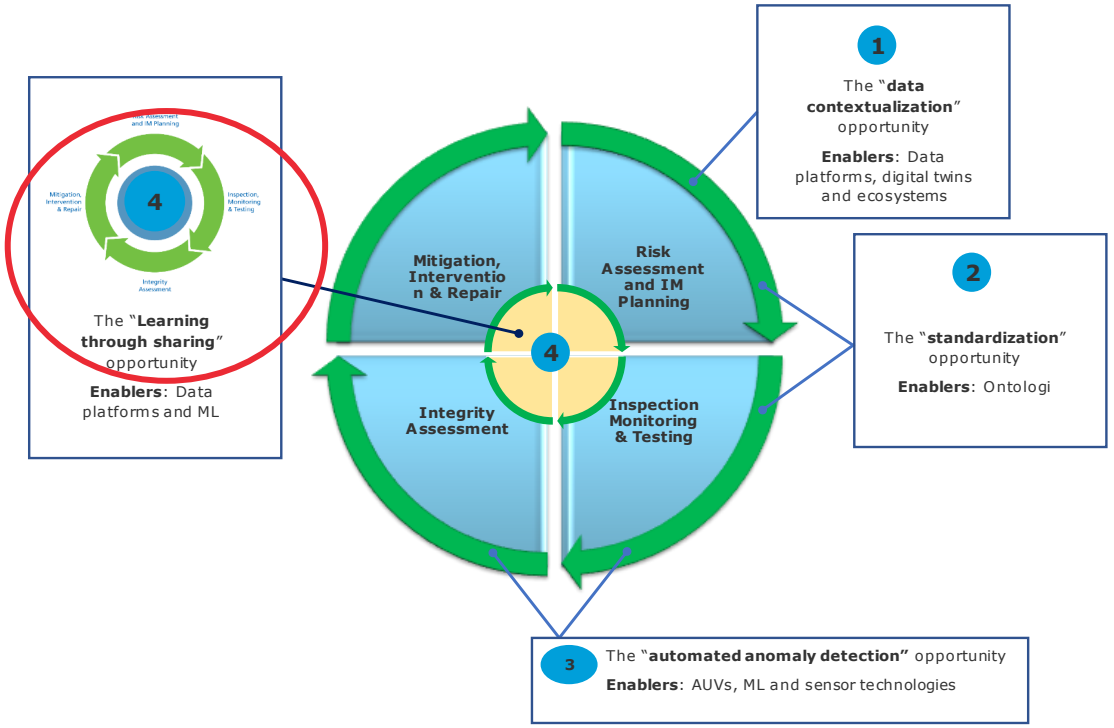
- Integrity related acceptance criteria and performance standards for subsea systems can be built into automated anomaly detection algorithms triggering the first steps of the integrity assessment process.
- Potential applications of automatic anomaly detection may be on data sets from ILI inspections, subsea surveys with AUVs, flexible riser monitoring and leak detection.
- The use of ML in these areas remains largely unexplored and represents a tangible opportunity for improved subsea integrity management.
- No significant barriers exist for this opportunity other than commonly observed barriers for adoption of ML such as lack of understanding, lack



Sec. 6 Opportunities

Learning through sharing

- Subsea integrity management is characterized by vast amount of data collected and available for use. There is a big value in all of these data sources if made freely available, accessible and searchable for all players.
- Work processes and systems to facilitate sharing of data and knowledge may be an enabler for learning and improved integrity management; in own organisation, in the supply chains and across the industry.



Main observations

- The subsea industry is investing in methods for improved data collection including significant investments into more autonomous underwater vehicles (AUVs). This to enable more frequent surveys and gather inspection data with better data quality that contributes to improved integrity understanding. However;
  - when it comes to use of the data there has been limited investments into automated anomaly detection and data integration to enable data driven condition models and risk models.
  - subsea integrity management is still to a large extent a manual process relying on finding the relevant data from a number of sources and for the subject matter expert to analyse large amounts of data to assess the technical condition, the associated risk, and plan the integrity management activities.
  - new enabling technologies such as cloud storage and computing as well as increased computational power has not yet triggered a significant change in how the subsea integrity is managed.

Main observations

- Data is to a large extent perceived to represent a cost and should to a larger extent be transformed to information in order to represent value.
- More open sharing of data, methods and models may enable the subsea industry to move faster forward through learning and innovation.
- Business cases to drive further development to create value from data should be developed through cross collaboration amongst engineering companies, service providers and oil & gas Operators.

Main observations

- Data driven condition and risk models will not reduce the need for subject matter experts within subsea systems and integrity management but will require new competences and new ways of working to effectively utilise the new enabling technologies.

  The development, which will require further investments to solve complex tasks, will require managers to understand the business value and set ambitious goals.

  The subsea industry should take more benefit from having become part of an IT industry and capitalize on the value of the vast amount of data available for use.

Main observations

- The development into more data driven subsea integrity management will further support the intentions of the PSA regulations and enable both cost reduction and safety improvements in the industry.
- At the same time, it is vital that PSA continues its role to enforce requirements related to data analysis and continuous improvement through its supervision activities.

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