



# Applying Predictive Analytics for Process Safety Management

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*The business of sustainability*



# Our Agenda for today

- Digitalization: Global & APAC Perspective
- Challenges to Digital Process Safety
- Digital PSM Pyramid
- Predictive Models for PSM: Analytics to Action
- Data Innovation Examples
- How to get started: Key Considerations



# Digitalization for Process Industries

## Global & APAC Perspective

*More than 75% are adopting Industry 4.0, Digital Transformation*

*Less than 25% are taking off beyond pilots*

*Industry expects digitalization efforts to reduce operation costs by 4.2% per year, boost revenue by 3.1 % per year*

*Process Companies ranks 3<sup>rd</sup> as an industry leading digital transformation, Automotive & Consumer goods being the leaders*

*60% companies place significant importance on data analytics*

*46% of the companies lack the capabilities & data*

*APAC as a region has 52% digital innovators and champions, highest when compared to NA (50%) and EMEA (25%)*

*Nearly half (48%) of the chemical industry respondents foresee a payback within two years*

*Technology is getting smarter, cheaper and better than yesterday – IoT, AR/VR, Drones, AI, Twins, Blockchain*

*70% companies believe People will remain the core drive digital success*

*Only 27% companies believe they have the right talent*

# Challenges to Digital Process Safety

*Key barriers to overcome*

Failure to learn from past incidents, communicating the learnings

Inefficient Management of Change for new process & technology adoption

Lost tribal knowledge - "How do we capture and digitize knowledge before it is gone?"

Lack of digital culture, skill sets and governance to drive the change

Failure to capture lessons into process design, procedures, training, maintenance and other programs

Lack of a concrete value proposition and business case to support digitalization

Lack of seamless integration between IoT and OT solutions

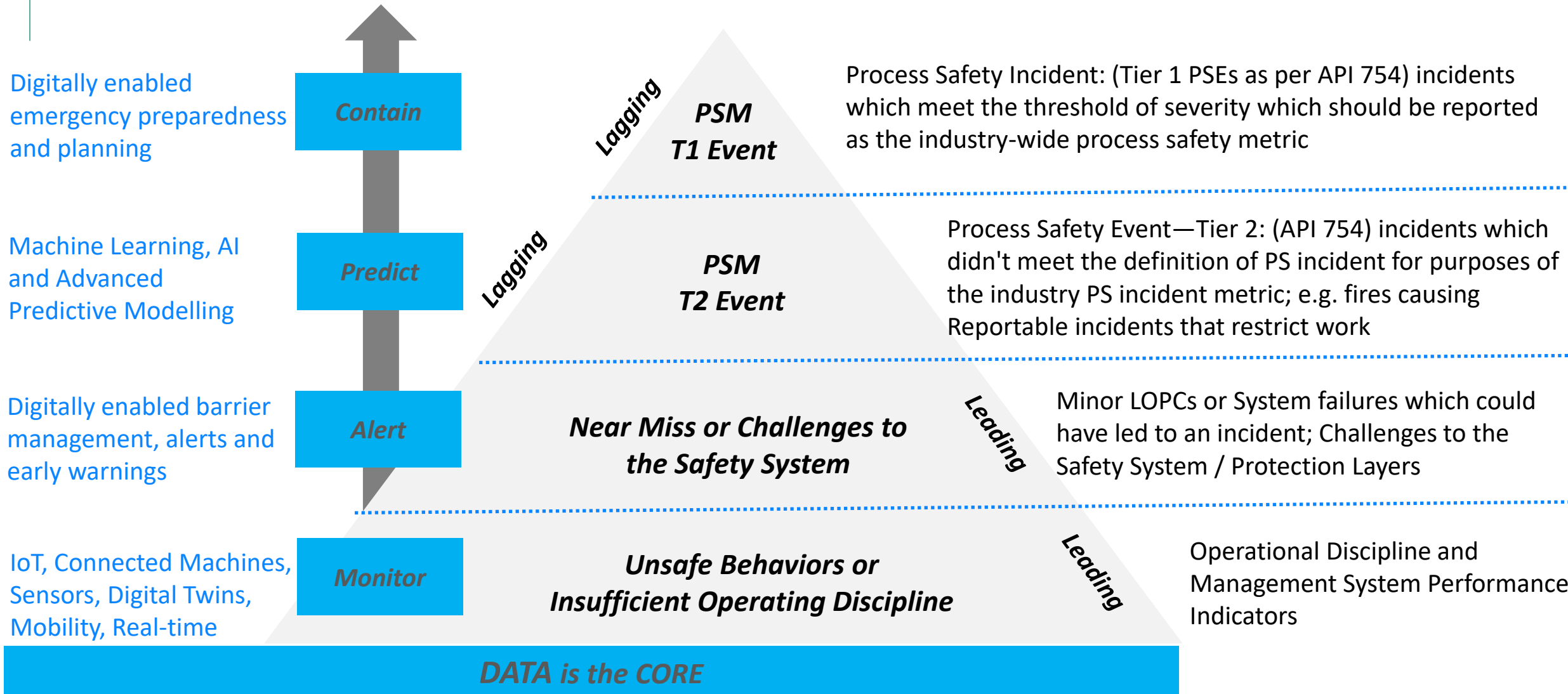
Silo and Decentralized information prevalent in existing infrastructure

Insufficient attention to leading indicators, lack of T3 & T4 indicators

Lack of best practice benchmarking to Operating Procedures

# Digital Process Safety Pyramid

## Intervention Levels



# Applying Analytical Models to Process Safety Management

## Prescriptive analytics

Quantifies the effect of future decisions. This is about recommendations/prescriptions on specific actions that need to be taken to meet the objective.

## Predictive analytics

Helps to understand the future and provide actionable insights.

## Diagnostic analytics

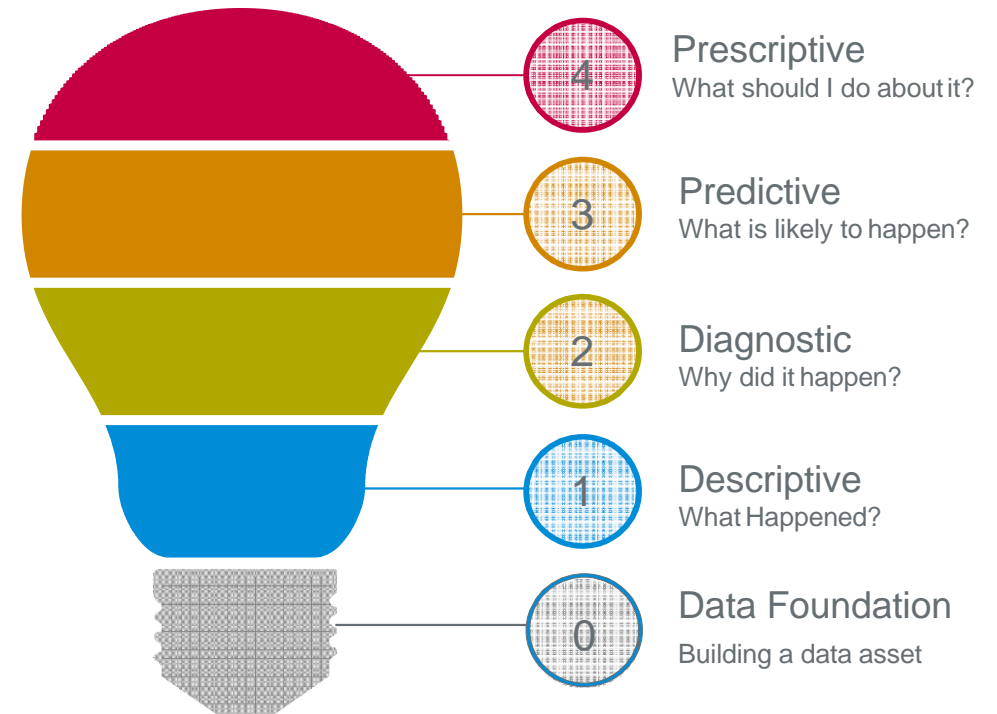
Identifies the causal drivers of observed effects. Diagnostic analytics capture the trends and patterns in the data and can help identify cause-effect relationships.

## Descriptive analytics

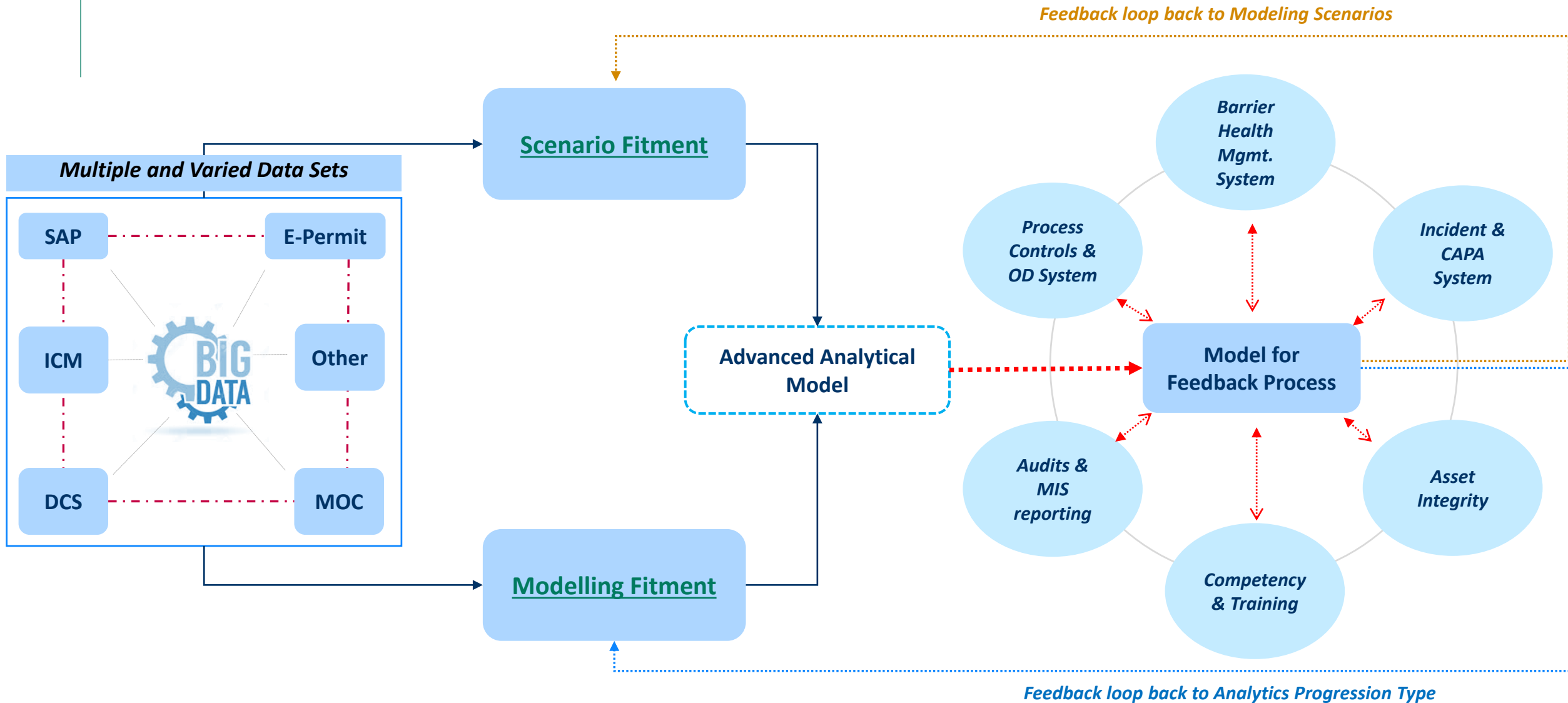
Describes or summarizes raw data and makes it interpretable. Descriptive analytics applications include standard reports that used in decision making, visualizations through GIS (e.g., geospatial data), and bubble charts (through Power BI).

## Data foundation

Getting your house in order. Understanding the data you have and the data you need to develop or acquire. Organizing the data and ensuring appropriate governance, data quality and data cleansing processes.

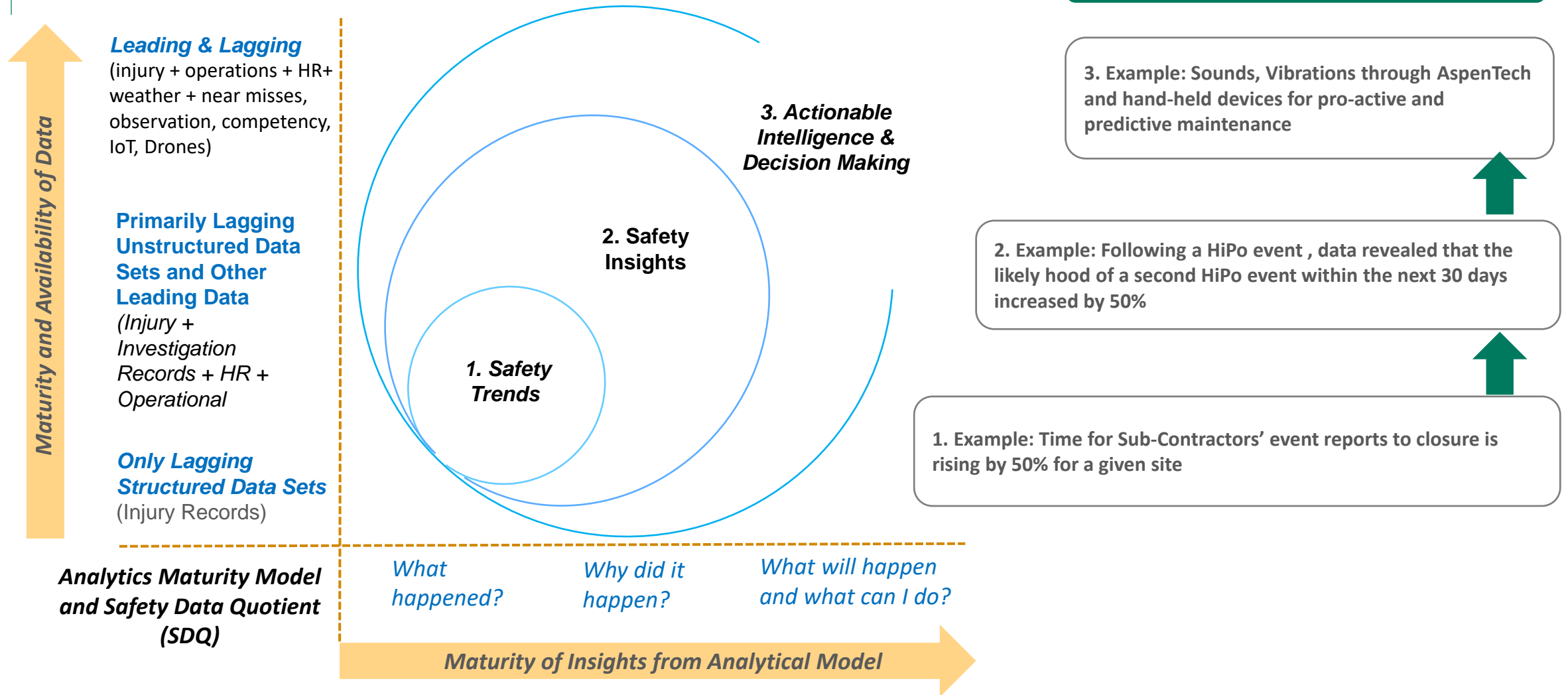


# ERM 'Analytics to Action' Model



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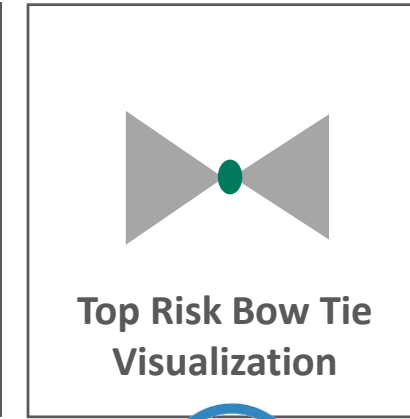
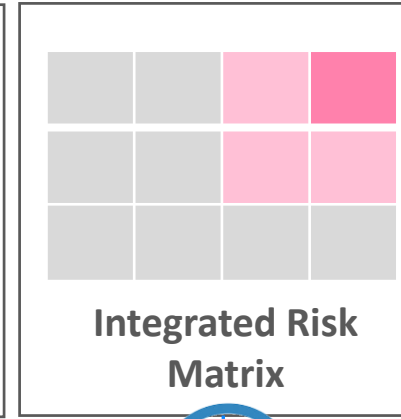
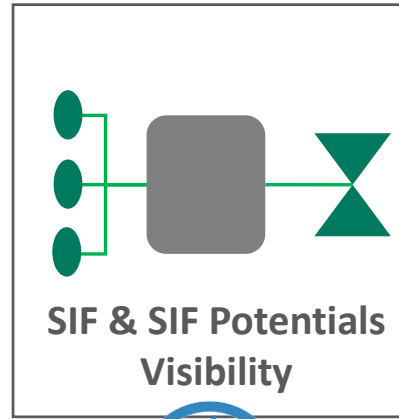
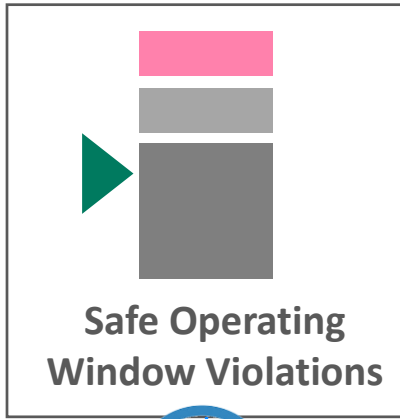
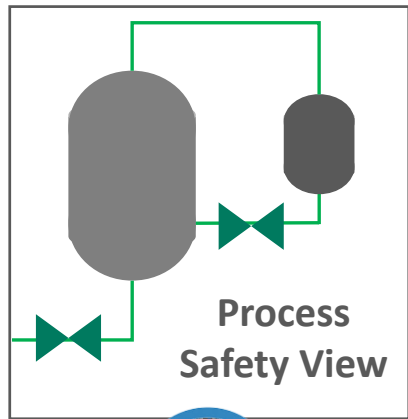
*Deploying the right strategy*





# Connected Process Safety Management

*How connected data, processes and systems will emerge?*



Connected PSM

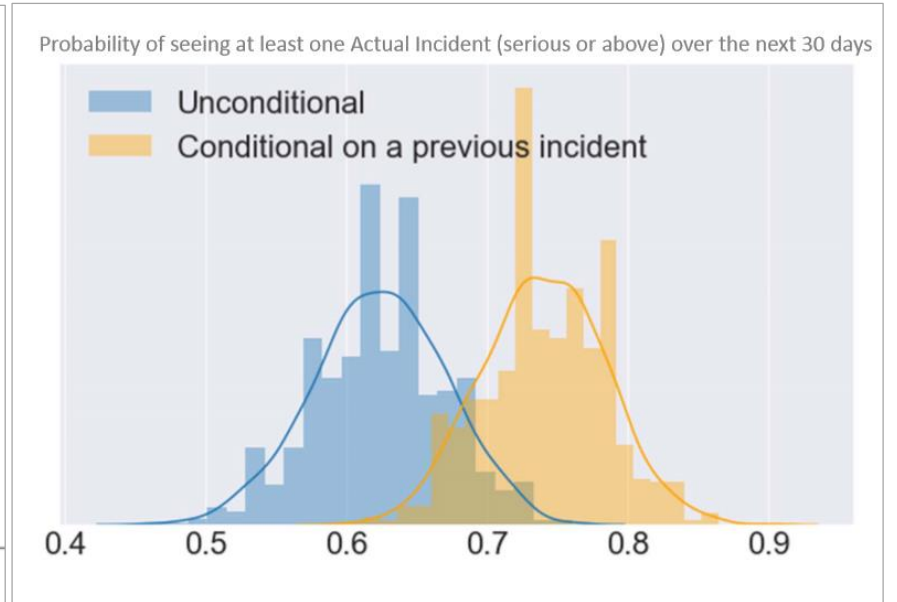
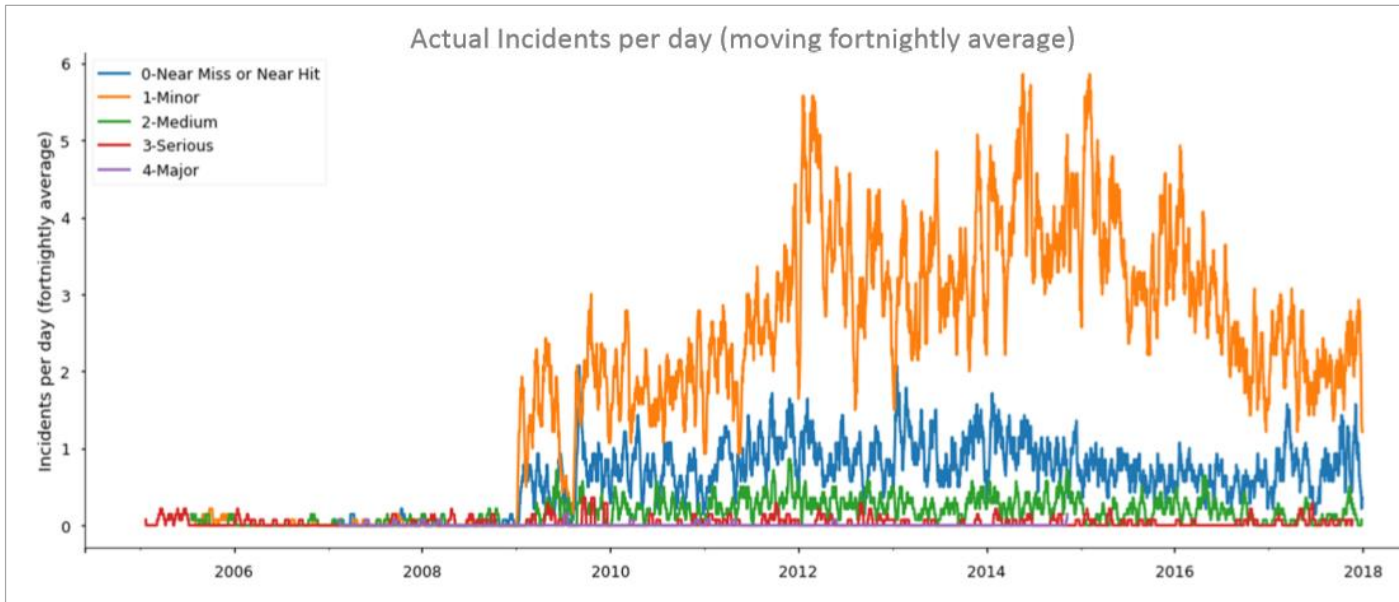
## BENEFITS

- **Digitally Connected Worker** at shop floor
- **Optimized Alerts and Warnings** for Tier 1 & Tier 2 Events
- **Connected Data and Learnings** from events
- Risk based **Digitization of preventative & mitigating barriers**
- **Predictive maintenance & inspection management**
- **Early Warning System with connected alarms**

# Look at some examples and case studies....



# Case Study 1: Advanced Injury Correlation Model



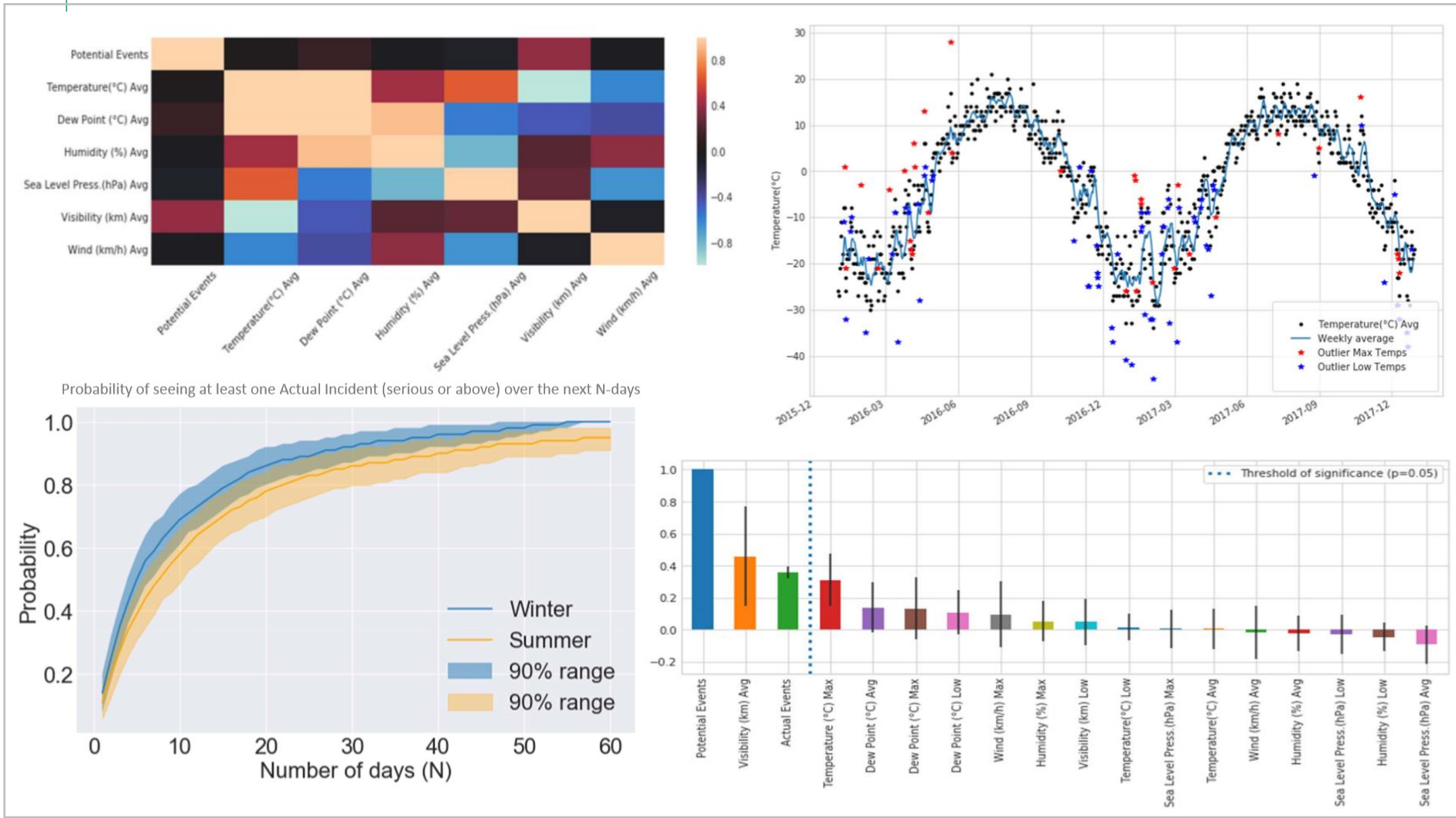
## Result Highlights

- There are much higher levels of minor incidents (orange trend) than any other type of incident;
- Most importantly that an apparent reduction in minor incident reports does not seem to result in a comparable reduction other incident classifications.
- The trend is correlated to lax in our reporting of less severe incidents / near misses

- On a “typical” day (blue curve) there is a probability of about 62% that a severe incident (serious or above) will happen in the next 30 days
- However, If an incident has just happened (orange data), this probably rises to about 74%

# Case Study 1: Advanced Injury Correlation Model

## Key Results

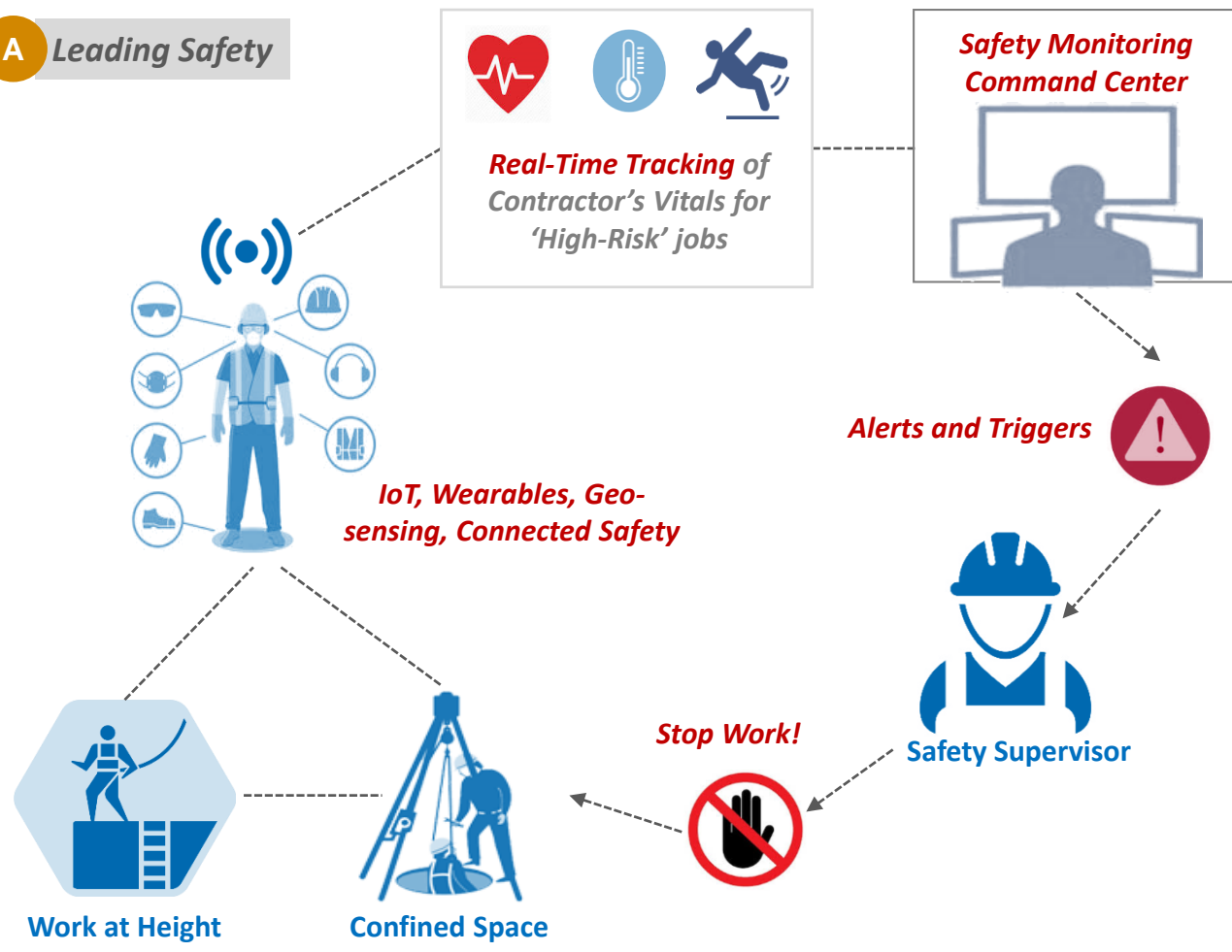


- Considering the exposed environmental and working conditions of this site, we were able to determine a positive correlation in injury potential during extreme winter months and days with low visibility
- The model showed increased events on days of unusual average visibility and maximum daily temperature. High model confidence levels established
- The model recommended the site to reduce scheduling of high risk job types during certain weather conditions (characteristics defined by model)

# Use Case 2: Connected Safety

*making safety smarter, agile & pro-active with data....*

## A Leading Safety

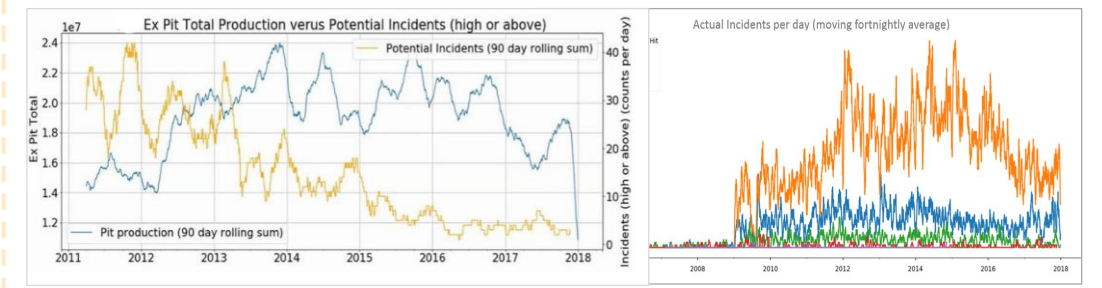


## B Lagging Safety



## C Connected Safety

### Safety Insights, Predictive Models, Pro-active Decision Making



# Use Case 3: Predictive Maintenance

Predictive modelling for equipment failure enabling understanding of unsafe conditions leading to injuries

## HYPOTHESIS

**Hypothesis:** Predictive Maintenance can help improve safety outcomes provided other Key contributing factors such as Workplace Safety, Operational Processes and Behavioral factors are factored into the Model

### Structured Equipment Data

IOT sensor and real time events – Vibration, Temperature, Acoustic Monitoring and Machine Oil Data, Equipment Maintenance Data and Alarms, Alerts etc.

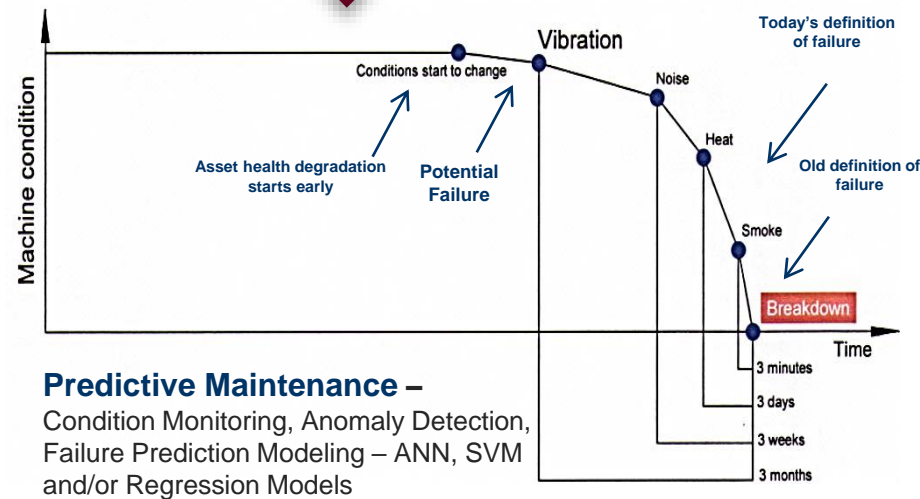


### Unstructured Operations Data

Safety Inspection, Incident Records, Shift/Roster Logs, Health records, Permit Records, PSM Audit, JSA, training and compliance (Unstructured - Text, Emails, Images, Video)



## MODELLING



**Predictive Safety Models** – Key challenge is around the fact that there are very few data points related to actual injuries compared to the ones for non-injuries. Therefore the focus should be on measuring conditions that are more likely to cause (Fatigue) an injury.

ERM is working on Unsupervised Text Analytics Safety Engines to focus on extraction and identification of relevant topics and themes to focus on. Further specific probabilistic algorithms such as Bayesian Models are under consideration for Modelling.

## ANALYSIS



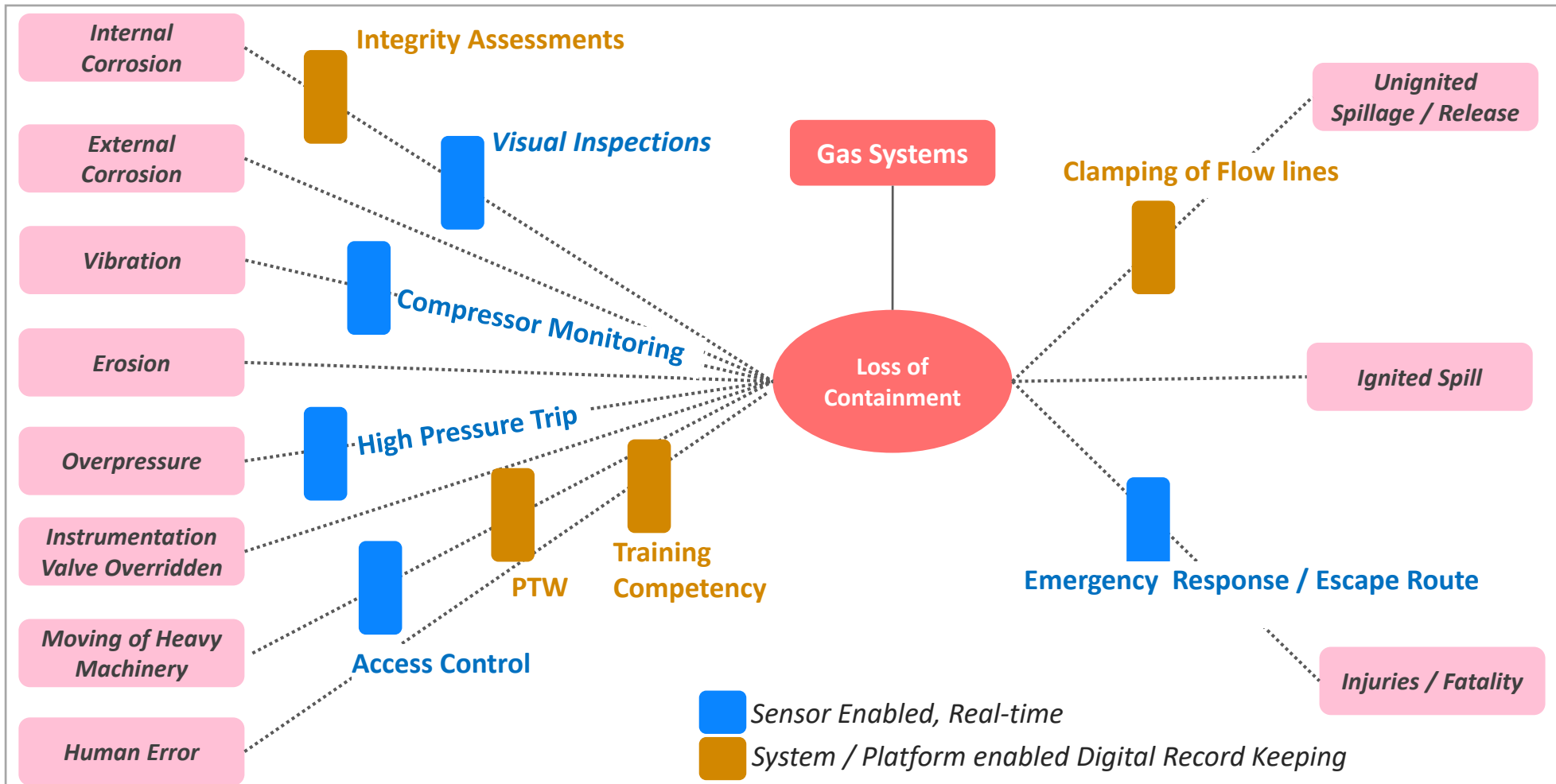
### Failure Predictions and Actions

- Our model was able to predict failures between 40 – 66% accuracy, with confidence of capturing 50 – 80% of actual failures
- The model identified direct correlations between shift changes and injury rate
- Safety professionals were able to visibility on unsafe condition, that in the modelled combination presented a higher chance of equipment failure and related machine injury
- SOPs were updated for shift handover for high risk jobs
- Maintenance cycles for the associated equipment were changed

# Use Case 4: Digital Twins for Barrier Health & LOPC Prediction

## Preventative Barriers

## Mitigating Barriers



## Digital Twins for Assets and Processes allowing

- Digitized system of records for PSM elements
- Critical equipment tagging, with respective IOWs, SOLs and Top Risk Scenarios
- Process Modelling & Simulation
- Real-Time Data Feed
- LOC Prediction Modelling

# Summarizing Thoughts

## *How to make data your biggest asset in PSM?*

### **1 Start with the end in mind**

A clear problem statement aligned with Safety Performance goals ('Reduce SIFs by identifying and mitigating precursors'), is as important as mining available datasets for insights.

### **2 Focus on TOP RISK; Leverage existing data**

Data analytics can get overwhelming if the top risk and existing systems & data assets are not considered. Start leveraging what you and go beyond traditional SHE data-sets

### **3 Be clear on the problems that data can solve**

Problem formulation defines questions and data requirements for analytics and insights. ERM works with Clients to prioritize these questions and analyses based on the anticipated business value, complexity, feasibility, and data availability.

### **4 Take a user-centered approach**

Understanding the user needs of all stakeholders (corporate to line worker) ensures the setting of an appropriate frame and priorities for the evaluation.

### **5 Gaining insights requires an integrated team**

The combined expertise of data scientists and subject matter experts working together, ensures the most relevant evaluations are executed, that findings align with business objectives, and that results are interpreted in the appropriate context.

### **6 Deeper insights often require greater data integration**

Data insight projects are more successful when multiple related datasets are applied to the problem. These datasets can be internal and external (i.e.: weather data and/or geo-location data in case of Safety and Risk).

### **7 Data preparation is critical and must be done correctly**

Data preparation can consume a large portion of the overall time and effort. Leveraging tools for automation at this stage may improve the process.

### **8 An iterative and agile mindset is essential**

Data Insight projects succeed when a succession of small iterative steps are taken (tightly-scoped data sets and hypotheses) rather than a single large step.

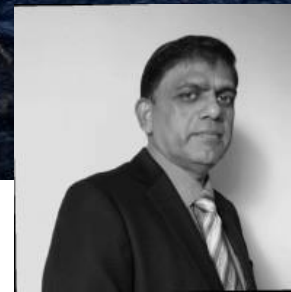




**Thank you**



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# Analytical Scenario Prioritization Matrix

Assessing if the analytical scenario has risk to business

Assessing if the variables in analytical equation are actionable

Assessing if the model is scalable for enhanced accuracy

Assessing if the timeline for implementation is practical

		Risk to Business	Actionable Nature of Variables	Model Scalability	Timeline for Implementation
Sample Scenario to be selected	Scenario 1	✓	✓	✗	✓
	Scenario 2	✗	✓	✓	✗
	Scenario 3	✗	✗	✓	✓
	Scenario 4	✓	✓	✗	✗
Sample Scenario to be selected	Scenario 5	✓	✓	✓	✓

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# Analytical Application Assessment Matrix

ERM uses the illustrated Analytical Application Assessment Matrix for mapping what level of algorithm or analytical model can be / shall be applied on organization's available data sets with respect to a defined problem statement.

For Predictive Models, the following 2 types will be leveraged :

- a) **Parametric Modelling** (example various types of regression models etc.). This modelling technique will be beneficial for defined / proven or high confidence correlations with limited variables.
- b) **Non-parametric Modelling** (example forest, neural networks etc.). This modelling technique is beneficial with analytical correlation assuming a large number of variables. Artificial Neural Networks can be used for non-linear system identification

