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Predictive maintenance Solution for industrial equipment using PI System®

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Agenda

- About Solvay and Radix
- Predictive System
- Project
- The Solution
- PI System Features
- Summary
- Benefits
- Next Steps

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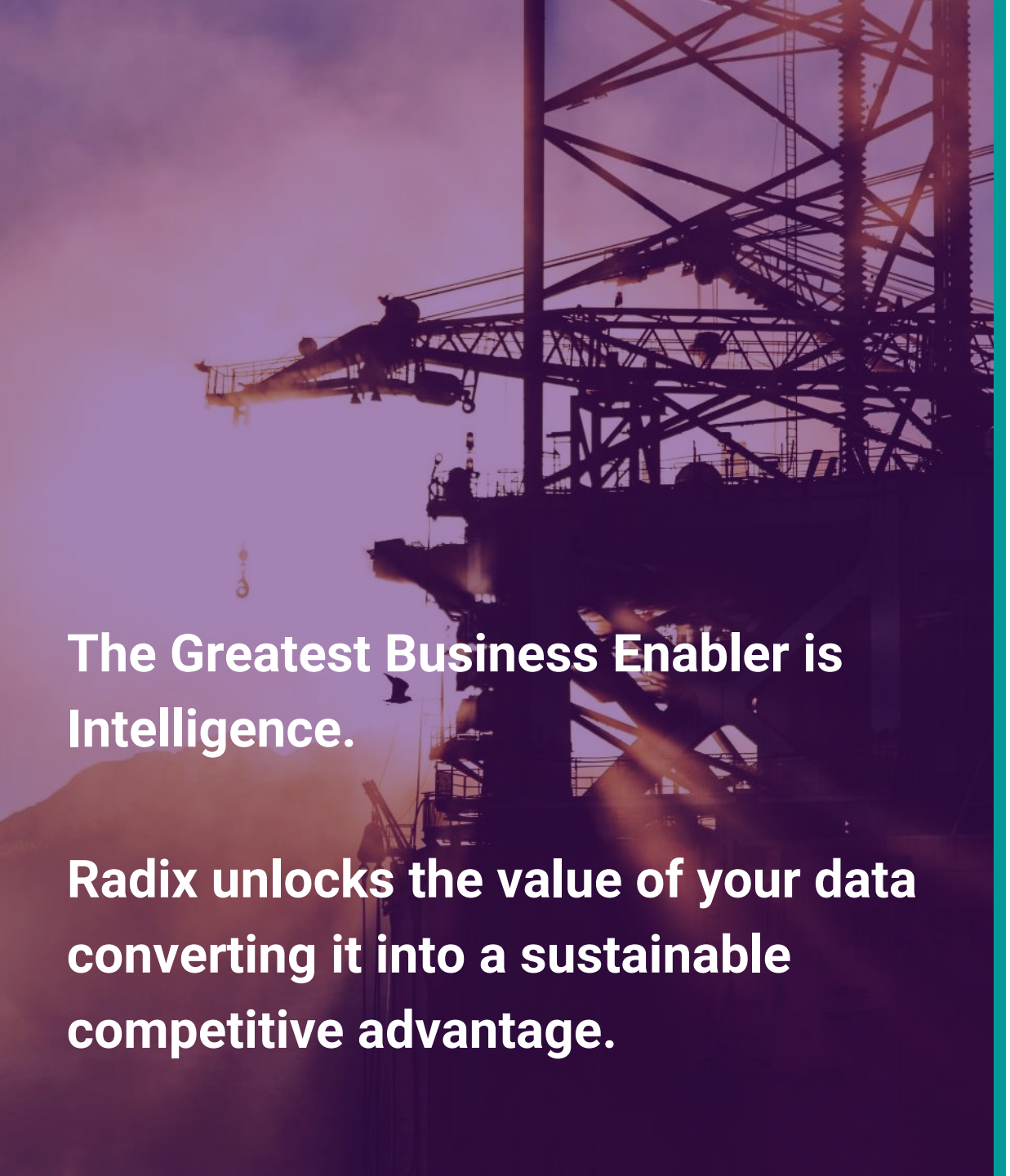

The Greatest Business Enabler is Intelligence.

Radix unlocks the value of your data converting it into a sustainable competitive advantage.

ABOUT RADIX

SOLVAY radix Engineering and Software

We are a **Digital Engineering** Company Innovation is our DNA

30 Years of Oil & Gas Domain Expertise Combined with a World Class Ecosphere of Software Technology Partners

1000+ Employees and Growing.
Financial Strength – Owned 70% by a $2B Caterpillar Dealer

Services provider with field presence worldwide, we have deep knowledge of the operations challenges

We have an Extensive Digital Suite which has been Established Across Multiple Verticals

We work with **Best In Class Oil & Gas Companies** with a Focus on EHS, Climate Change & Delivering Enabling Financial Impact

AVEVA

CORE EXPERTISE – WE COMBINE THE OT, IT AND ET WORLDS

Engineering Technology

- Conceptual and Special Studies
- Multidisciplinary Capital Engineering (Basic to Detailed Design all disciplines)
- Rotating Equipment / critical system special studies
- Construction and Commissioning Support

Operation Technology

- Conceptual and Consulting Services
- Traditional Automation (PLCs, DCSs and SCADA)
- IIoT and Instrumentation (Data Gathering)
- Industrial Networks and Cyber Security
- Machine Learning and AI
- Rotating Equipment / critical systems Troubleshooting
- System/Application Support

Information Technology

- Tailored Software Development
- Software Architecture and Platforms
- Bid Data and Analytics
- Governance
- Software Support

Radix differentiates by the combination of **ET, OT** and **IT**.

Providing **complete solutions** from the physical problems to the functional system.

About Solvay

A science company whose technologies bring benefits to many aspects of daily life.

The innovative solutions contribute to safer, cleaner, and more sustainable products found in homes, food and consumer goods, planes, cars, batteries, smart devices, health care applications, water and air purification systems.

Solvay Group seeks to create sustainable shared value for all, notably through its Solvay One Planet plan crafted around three pillars: protecting the climate, preserving resources and fostering better life.

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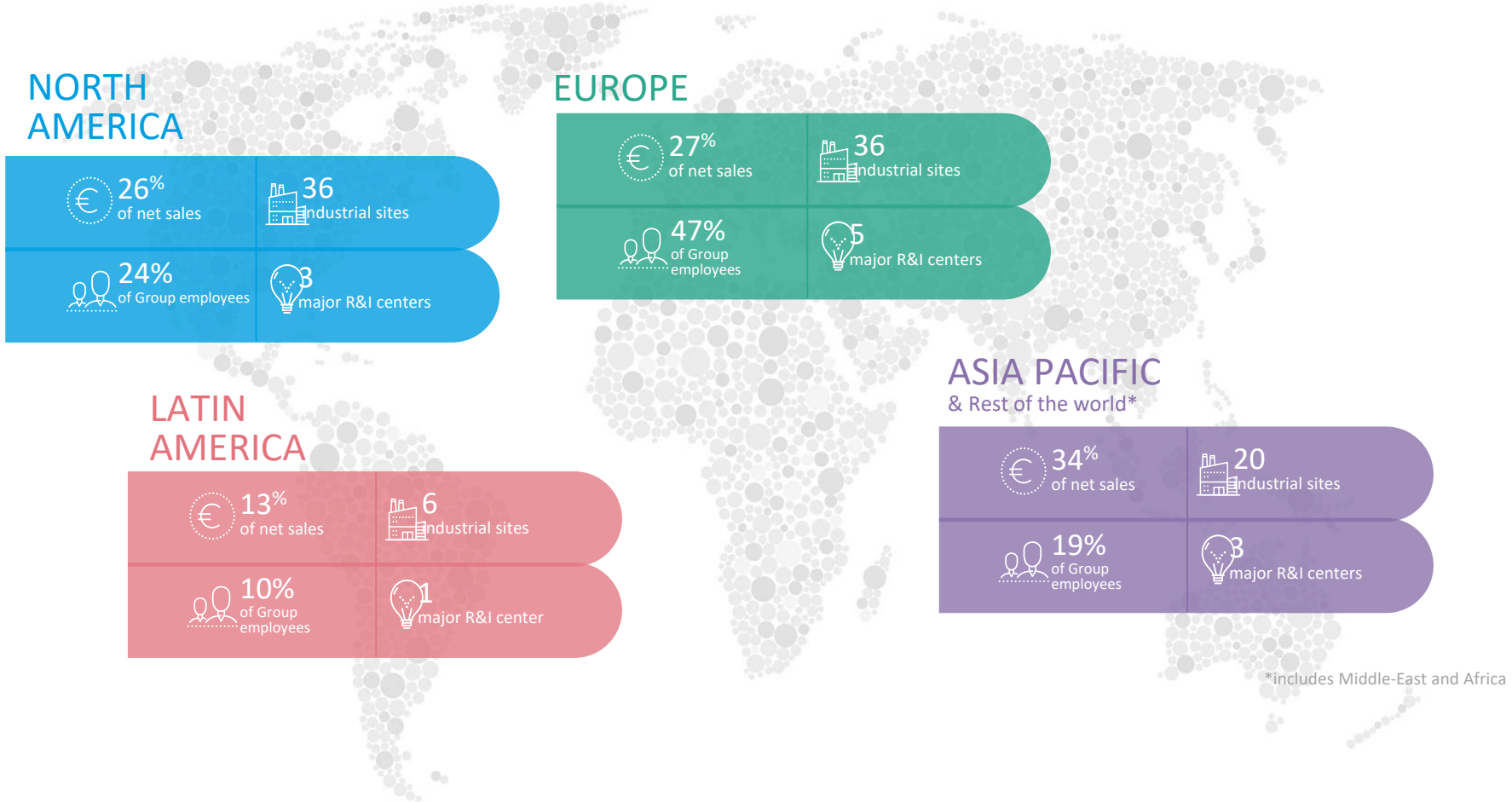
About Solvay



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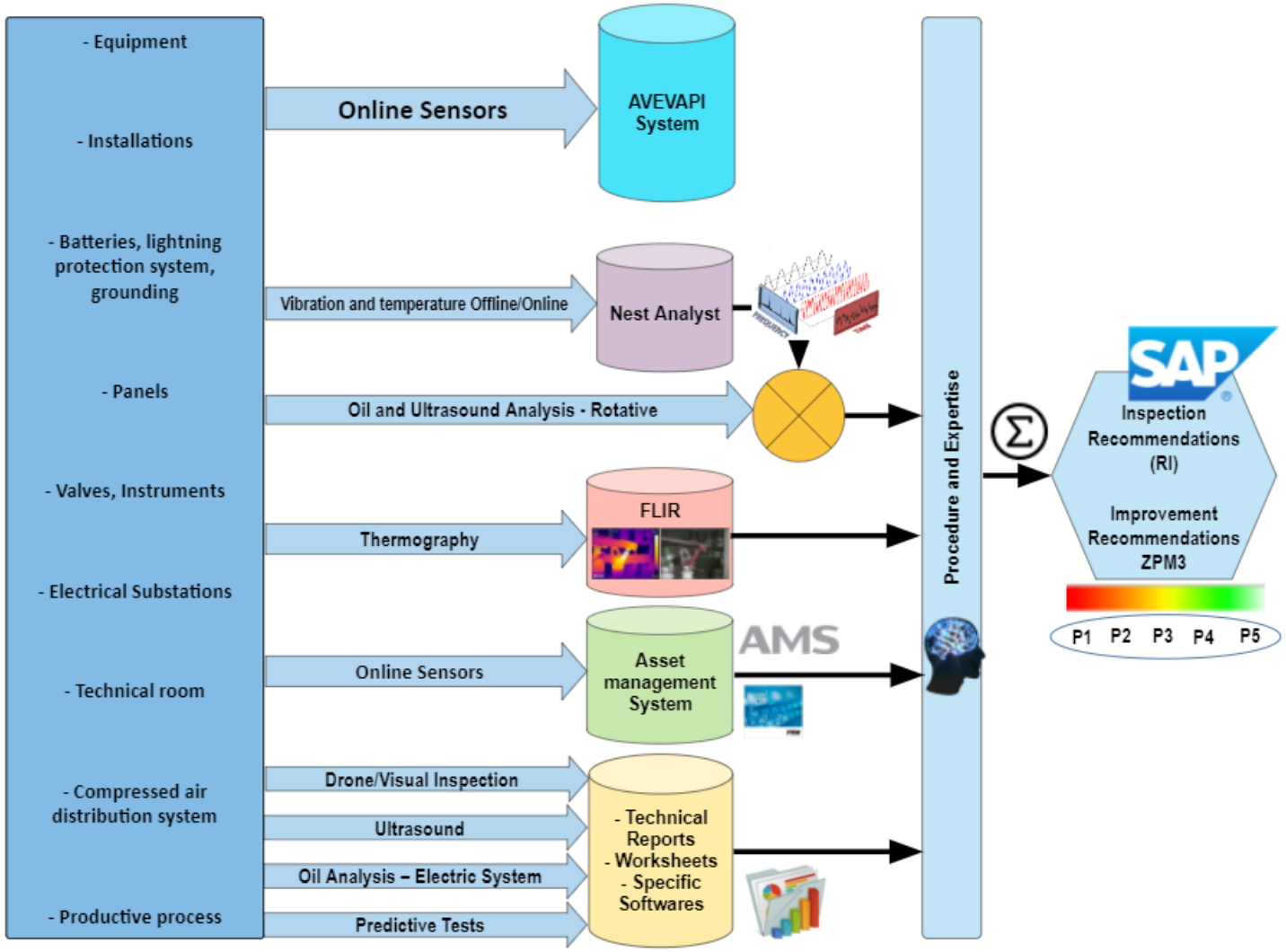
Predictive process before PredMaiS Project



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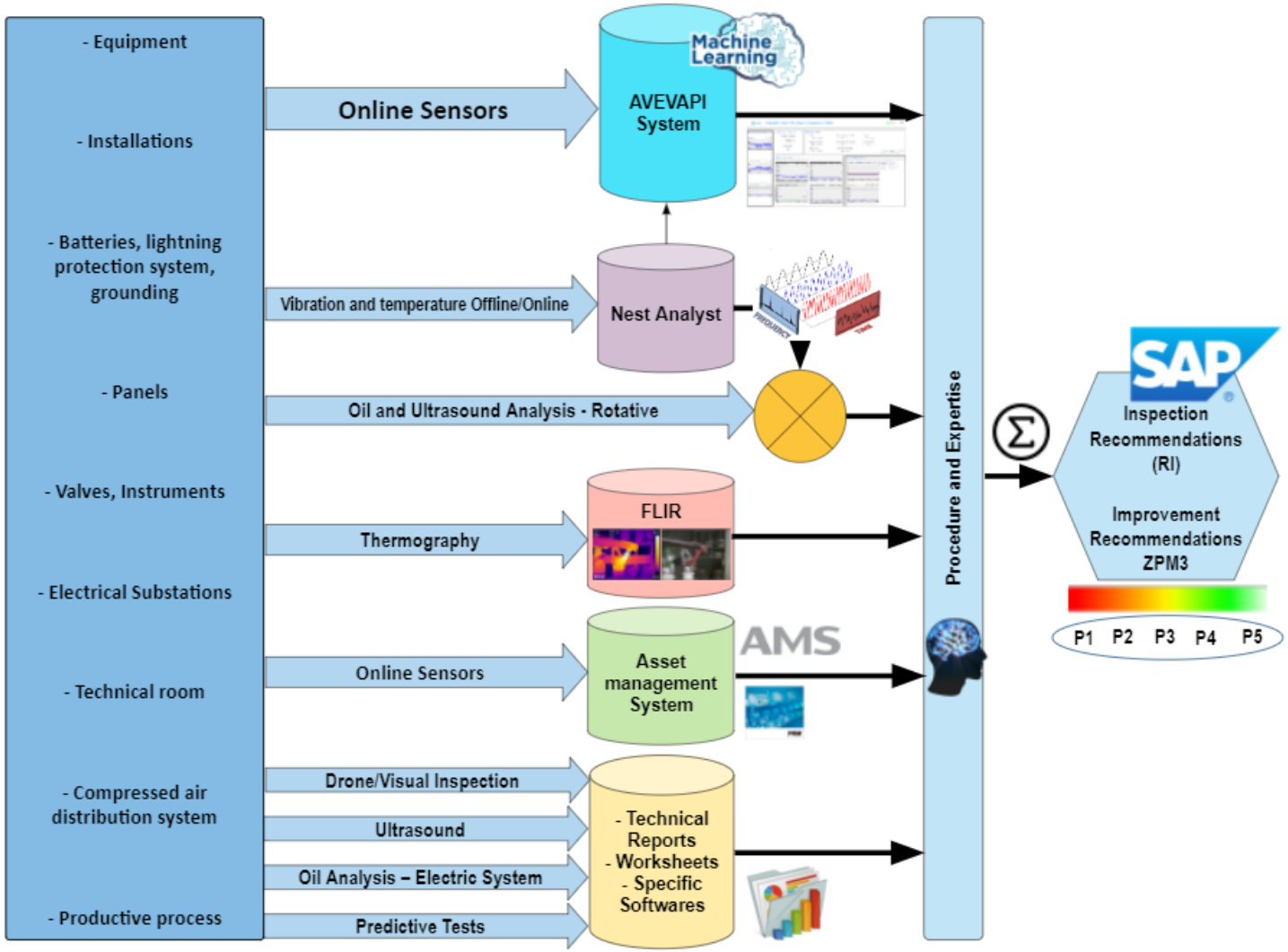
Predictive process after PredMaiS Project



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Pilot PredMaiS Project

Predictive Maintenance System

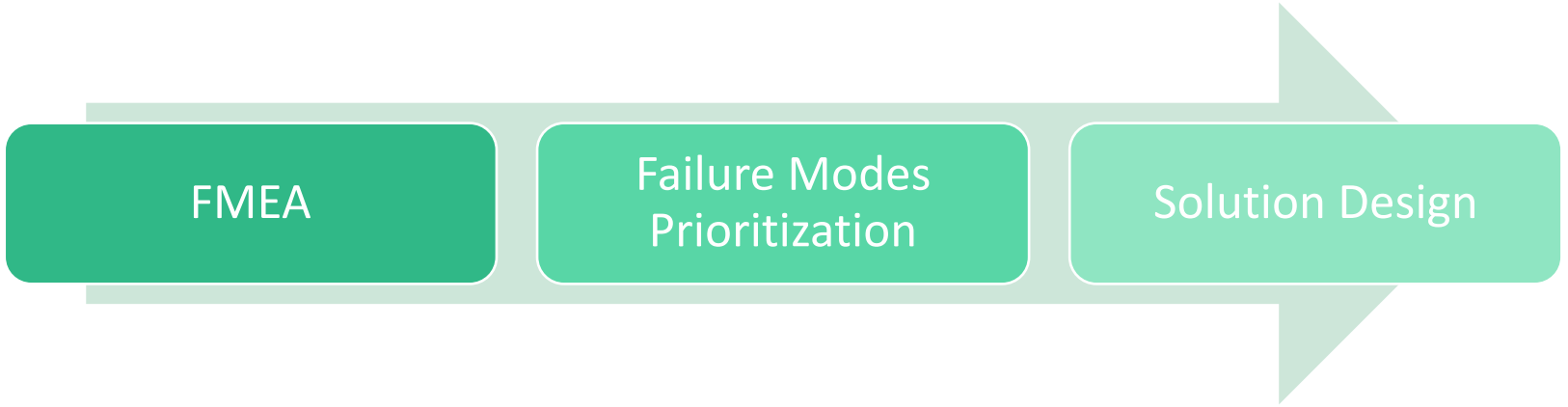
Scope

4 Critical pieces of Equipment:

- 1 Centrifugal Pump (boiler)
- 1 Fan (Carbon Abatement Plant)
- 1 Centrifugal Compressor (Chiller)
- 1 Liquid ring Compressor (Adipic Acid Plant)

Challenge

Lack of instruments for predictive solution to cover the failure modes



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Phase 2 PredMaiS Project

Predictive Maintenance System

Scope 2020/21

169 pieces of Equipment from categories:

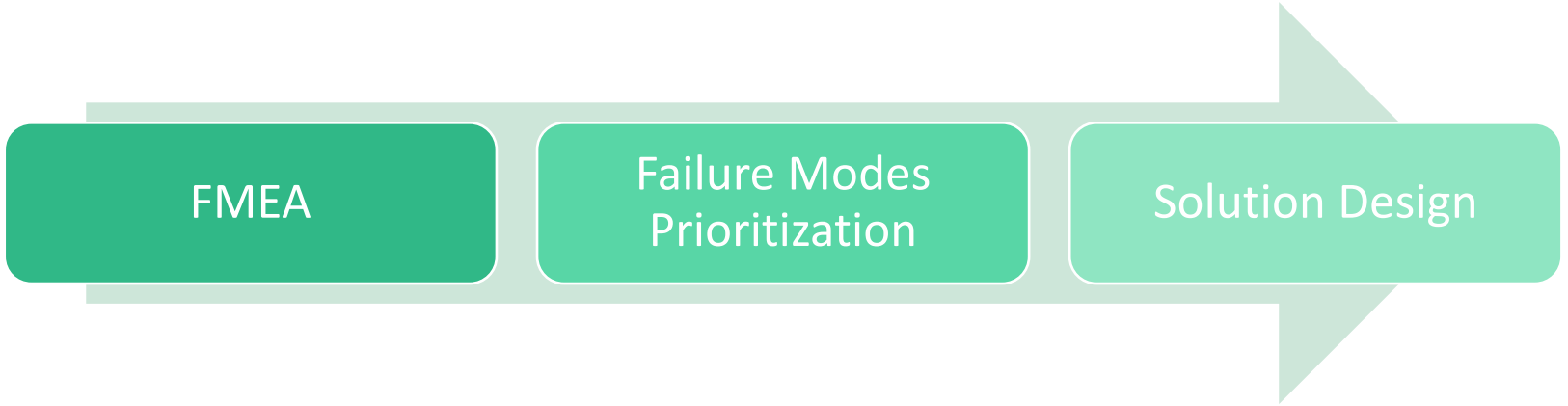
- 141 Pumps
- 1 Cooling Tower
- 13 Fans
- 10 Compressors
- 3 Liquid ring Compressor
- 1 Steam turbine

Challenge

Install 323 instruments for predictive solution to cover the failure modes

Solution

IIot: wireless instruments



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PredMaiS Project – Failure Modes Prioritization

Predictive Maintenance System – Engineering calculus solution

Pump
- Cavitation
- Efficiency
- Bearing degradation, misalignment, unbalance
- Mechanical seal leak
- Motor degradation

Fan
- Efficiency
- Bearing degradation, misalignment, unbalance
  Motor degradation

Cooling Tower
- Efficiency
- Bearing degradation, misalignment, unbalance
  Motor degradation

Centrifugal compressor
- Efficiency
- Bearing degradation, misalignment, unbalance
- Motor degradation
- Surge
- Heat exchanger condition

Liquid ring compressor
- Cavitation
- Efficiency
- Bearing degradation, misalignment, unbalance
- Mechanical seal leak
- Motor degradation
- Liquid ring condition (flow and temperature)
- Heat exchanger condition

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PredMaiS Project – Steam turbine Solution

Predictive Maintenance System – Machine learning solution

Failure Modes Prioritization

- Efficiency
- Bushing degradation,
- Generator degradation
- Control Valve failure
- Moog/Control System failure
- Lubrication failure

Solution

- Engineering calculus
- Machine learning
- Failure prevision in 2 weeks
- Failure prevision for vibration in 10 hours

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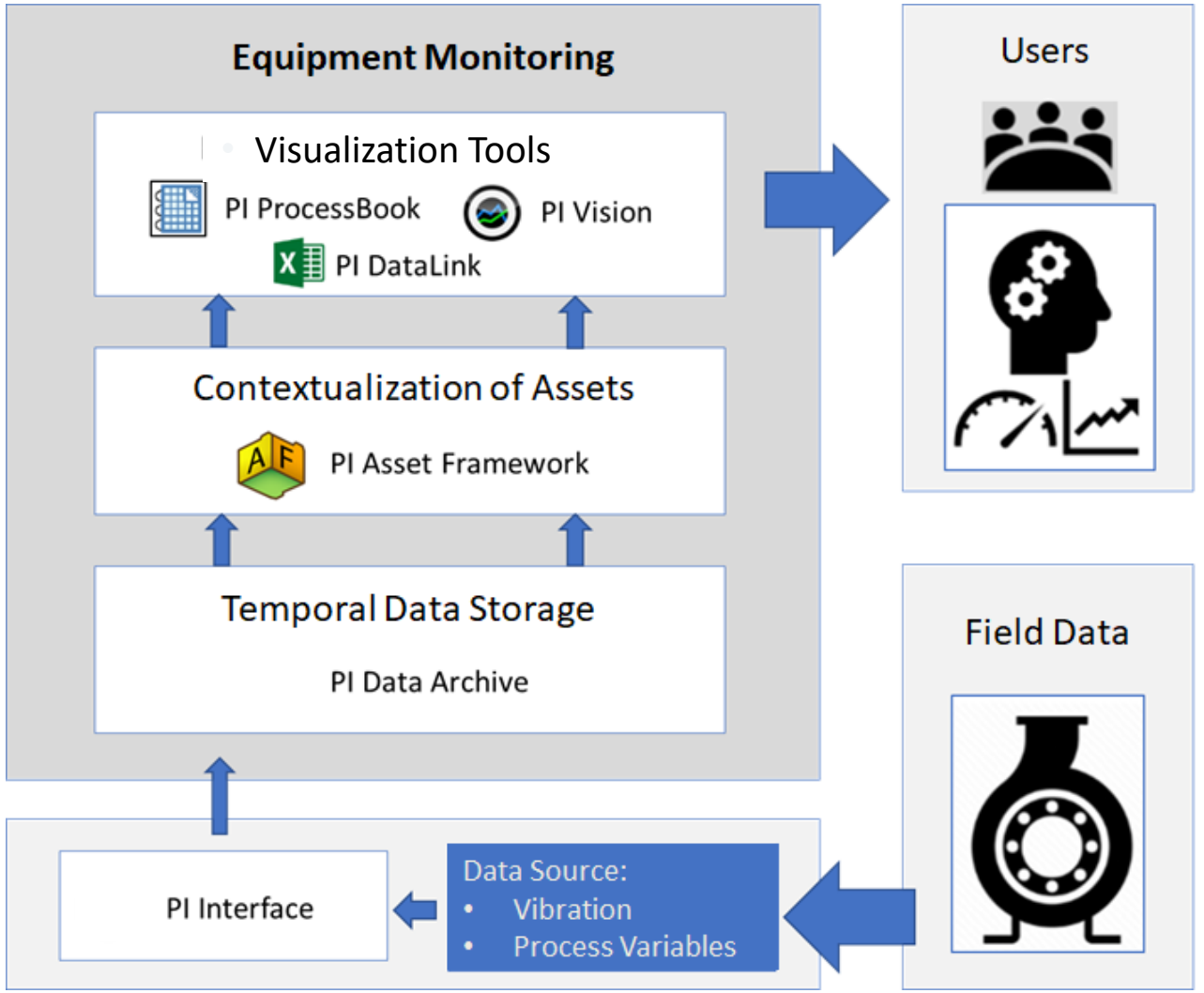
PI System Features

Overview

Dashboards

- **~ 25,000 tags** mapped in the PI Data Archive;
- Over **150 assets** and **50 templates** in PI AF;
- More than **15,000 PI Asset Analytics** running;



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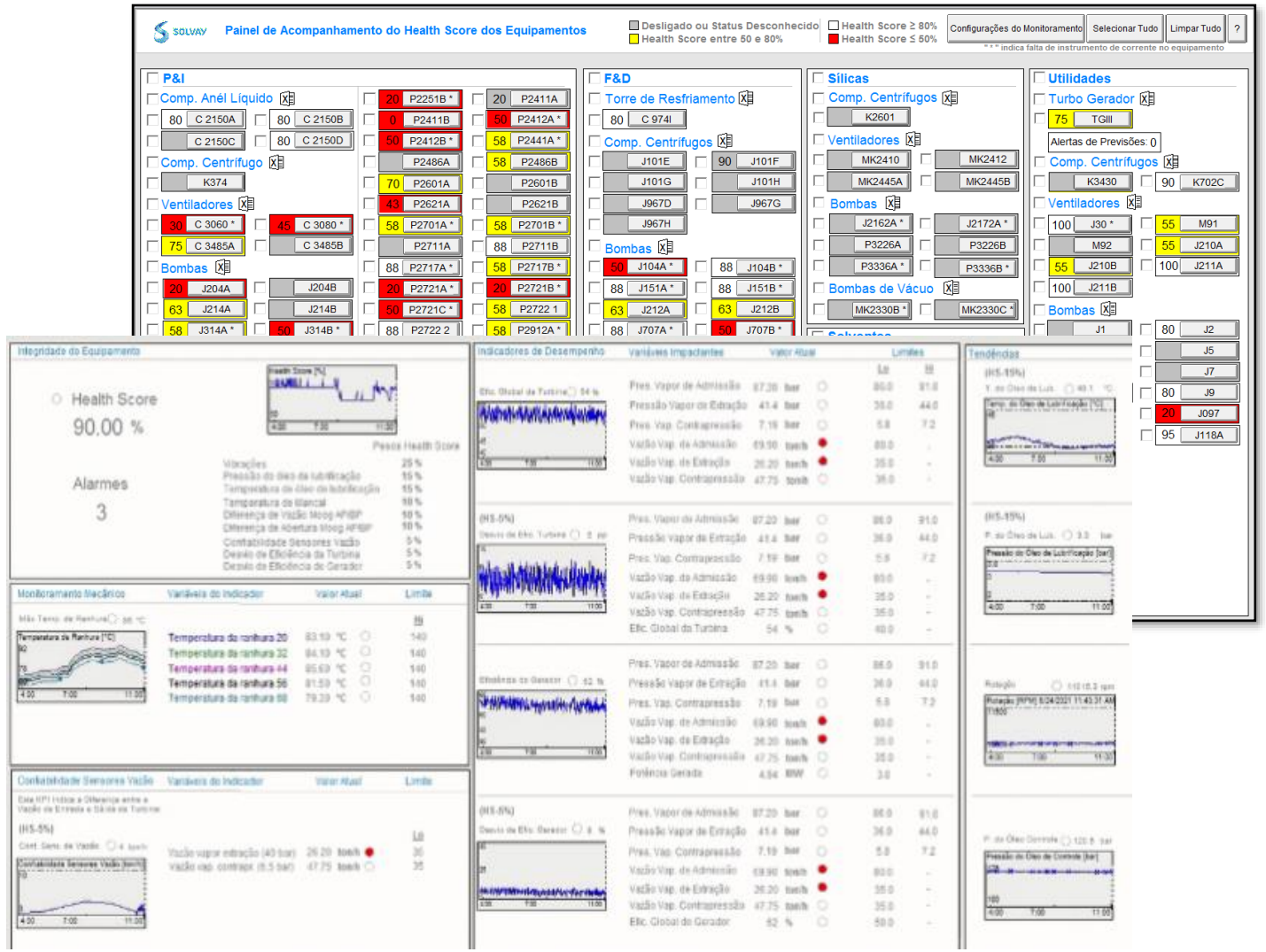
Solution

Predictive Maintenance System

Dashboards

- PI AF Element Template associated with a Symbol Template significantly reduced the application development and maintenance time;
- PI Asset Analytics enabled the calculation of complex status for multi-state symbols;
- Trend Graphics and historian to Analogical Data



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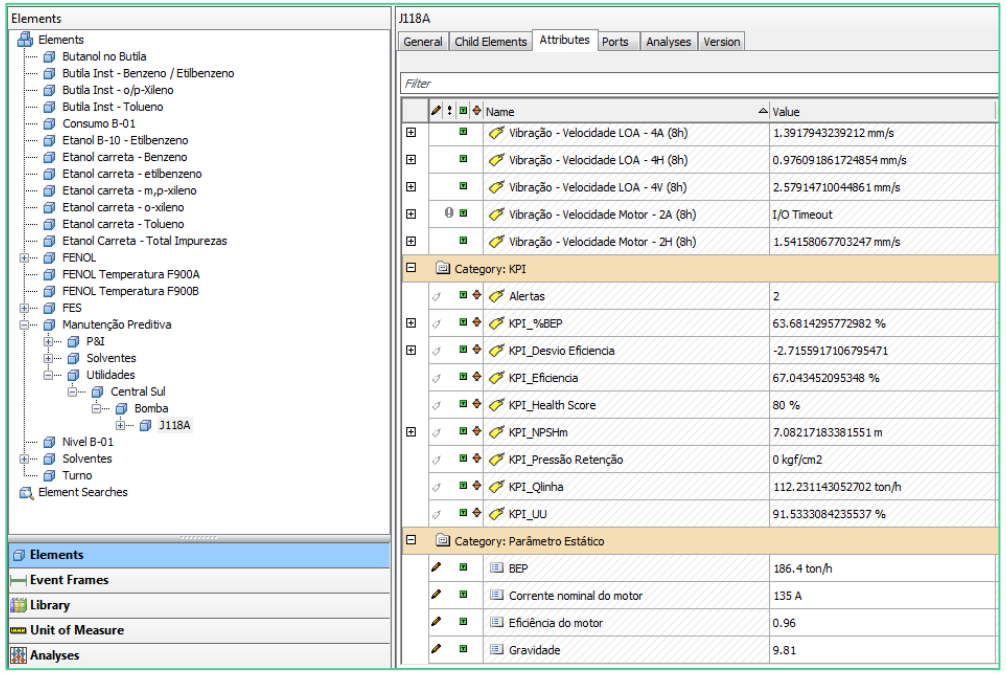
Solution

Overview

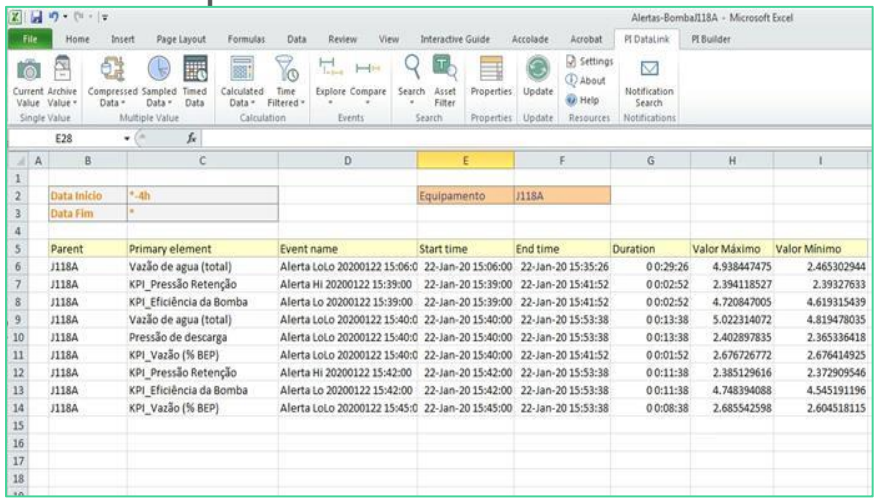
Basic Components of Solution

Analysis Implementation - PI Asset Framework



Monitoring Screen – PI ProcessBook

Alert Report – PI Data Link Excel



Parent	Primary element	Event name	Start time	End time	Duration	Valor Máximo	Valor Mínimo
J118A	Vazão de agua (total)	Alerta LoLo 20200122 15:06:0	22-Jan-20 15:06:00	22-Jan-20 15:35:26	0 0:29:26	4.938447475	2.465302944
J118A	KPI_Pressão Retenção	Alerta Hi 20200122 15:39:00	22-Jan-20 15:39:00	22-Jan-20 15:41:52	0 0:02:52	2.394118527	2.39327633
J118A	KPI_Eficiência da Bomba	Alerta Lo 20200122 15:39:00	22-Jan-20 15:39:00	22-Jan-20 15:41:52	0 0:02:52	4.720847005	4.619315439
J118A	Vazão de agua (total)	Alerta LoLo 20200122 15:40:0	22-Jan-20 15:40:00	22-Jan-20 15:53:38	0 0:13:38	5.022314072	4.819478035
J118A	Pressão de descarga	Alerta LoLo 20200122 15:40:0	22-Jan-20 15:40:00	22-Jan-20 15:53:38	0 0:13:38	2.402897835	2.365336418
J118A	KPI_Vazão (% BEP)	Alerta LoLo 20200122 15:40:0	22-Jan-20 15:40:00	22-Jan-20 15:41:52	0 0:01:52	2.676726772	2.676414925
J118A	KPI_Pressão Retenção	Alerta Hi 20200122 15:42:00	22-Jan-20 15:42:00	22-Jan-20 15:53:38	0 0:11:38	2.385129616	2.372909546
J118A	KPI_Eficiência da Bomba	Alerta Lo 20200122 15:42:00	22-Jan-20 15:42:00	22-Jan-20 15:53:38	0 0:11:38	4.748394088	4.545191196
J118A	KPI_Vazão (% BEP)	Alerta LoLo 20200122 15:45:0	22-Jan-20 15:45:00	22-Jan-20 15:53:38	0 0:08:38	2.685542598	2.604518115

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Solution

Overview

Basic Components of Solution

- Event History Detailing
- User can define equipment and start or end times of Search data

Alert Report

Paulínia/SP

Equipment	P2193A
Start data	*-1m
End Data	*

Parent	Primary element	Event name	Start time	End time	Duration	Valor Máximo	Valor Mínimo
P2193A	Vibração - Velocidade LA - V	Alerta Hi 2021-04-30 23:03:00	30-Apr-21 23:03:00		29 13:06:14	3.723501205	1.838592768
P2193A	Corrente do motor	Alerta Hi 2021-04-30 23:03:00	30-Apr-21 23:03:00		29 13:06:14	176.5	0
P2193A	KPI_Vazão Total	Alerta LoLo 2021-05-05 17:15	05-May-21 17:15:00		24 18:54:14	60892.82467	-620.0153637
P2193A	KPI_Desvio de Eficiência	Alerta HiHi 2021-05-07 05:19:	07-May-21 05:19:00		23 6:50:14	5.23236E+18	-2.67392E+23
P2193A	Vibração - Velocidade LOA - H	Alerta HiHi 2021-06-02 02:50:	02-Jun-21 02:50:00		27 9:19:14	4.896599293	3.107298851
P2193A	Vibração - Velocidade LA - H	Alerta HiHi 2021-06-02 02:50:	02-Jun-21 02:50:00		27 9:19:14	5.557481766	2.872358799
P2193A	KPI_Vazão Total	Alerta HiHi 2021-08-11 10:45:	11-Aug-21 10:45:00		17 1:24:14	56238.9137	-2.737994288
P2193A	KPI_Desvio de Eficiência	Alerta LoLo 2021-08-11 10:50	11-Aug-21 10:50:00		17 1:19:14	57.63402911	-8871363991
P2193A	KPI_Vazão Total	Alerta Lo 2021-09-27 09:56:0	27-Sep-21 09:56:00		1 2:13:14	34272.7376	24640.79463
P2193A	KPI_Vazão (% BEP)	Alerta Lo 2021-09-27 09:56:0	27-Sep-21 09:56:00		1 2:13:14	49.25761247	32.3882146
P2193A	Vibração - Velocidade LOA - H	Alerta Hi 2021-09-27 09:56:0	27-Sep-21 09:56:00		1 2:13:14	3.107298851	3.107298851
P2193A	Vibração - Velocidade LA - H	Alerta Hi 2021-09-27 09:56:0	27-Sep-21 09:56:00		1 2:13:14	3.402711868	3.402711868

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Summary

Main Results

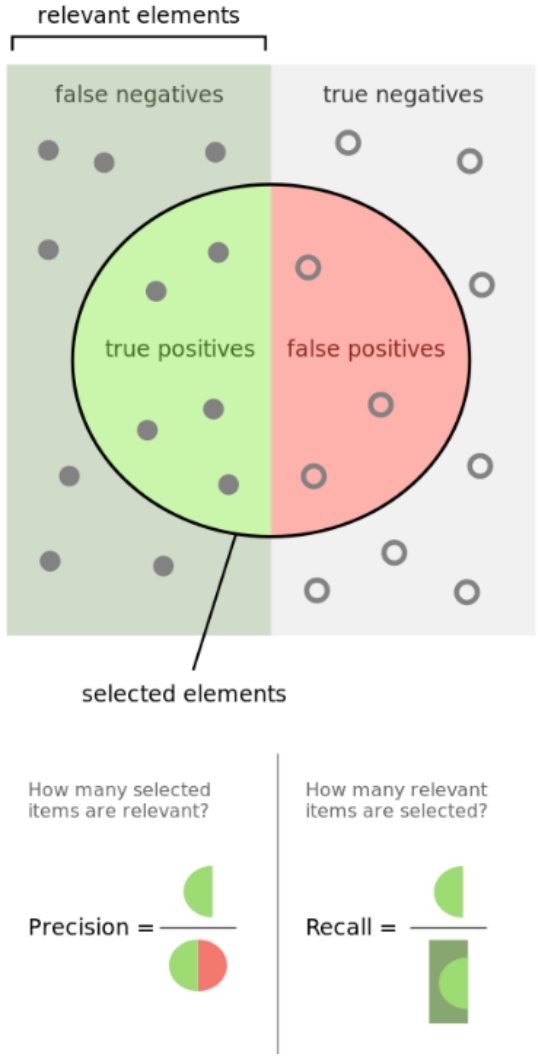
Avoided Loss Events (2 Phases)

- **Reference:**

Recall = TP / (TP + FN) > 80%
Precision = TP / (TP + FP) > 80%
F-score = 2*(Precision * Recall) / (Precision + Recall) > 80%

- **Actual Status:**

True Positive(TP) = 55
False Positive (FP) = 1
False Negative (FN) = 1
Recall = 98,2%
Precision = 98,2%
F-score = 98,2%



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Summary

Main Results

CHALLENGE	SOLUTION	RESULTS
• Provide a solution that enables real time and historical data analysis on the Equipment Health conditions. • Lack of instruments: costs and timing (search for more competitive sensors) • Dashboard supervision	• PI Asset Framework and PI Asset Analytics; • Dashboards in PI Processbook; • Excel to historical data for analysis and reporting; • PI Event Frames to detect and present information with start and end conditions. • Notifications by email to maintenance team when the health score reduces below 50%.	• Maintenance cost reduction (Preventive and Corrective Scope) by 55.2% (one-year evaluation) of Pilot. • Increased communication between the Maintenance and Production areas. • Increase in the number of work orders related to the basic condition by 360%. • Increase the knowledge on equipment by the Maintenance team

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Summary

Main Results

PAY-BACK (one-year evaluation of **Pilot** equipment´s maintenance costs)

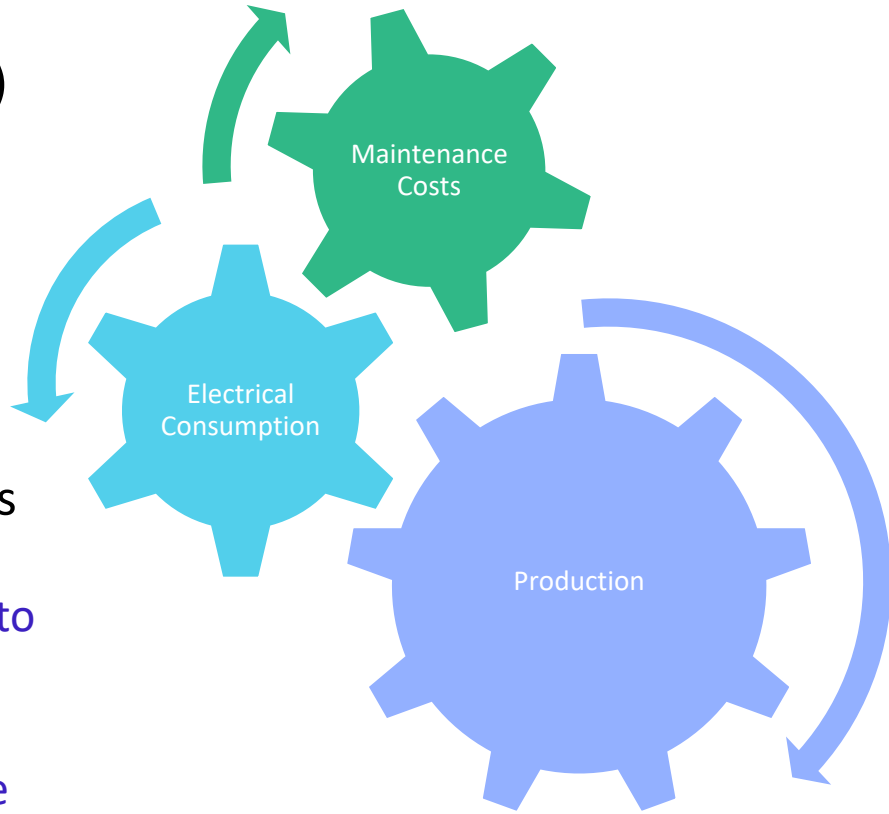
- Without taking the advantages of reduction of electrical consumption and improve production

AVEVA PI System Solution (service) = 2 Years

- Cost reduction by 55% for corrective and preventive work orders.

AVEVA PI System Solution (service) and instruments installation = 8 years

- With wired sensors. Main challenge to progress (open to brand new alternatives including startups for breakthrough) as this will block expansion to further phases
- For the current phase of Predmais (using wireless technology), the payback improved to 3 years as we are taking advantage of all opportunities to reduce infrastructure costs. We will keep on this journey.



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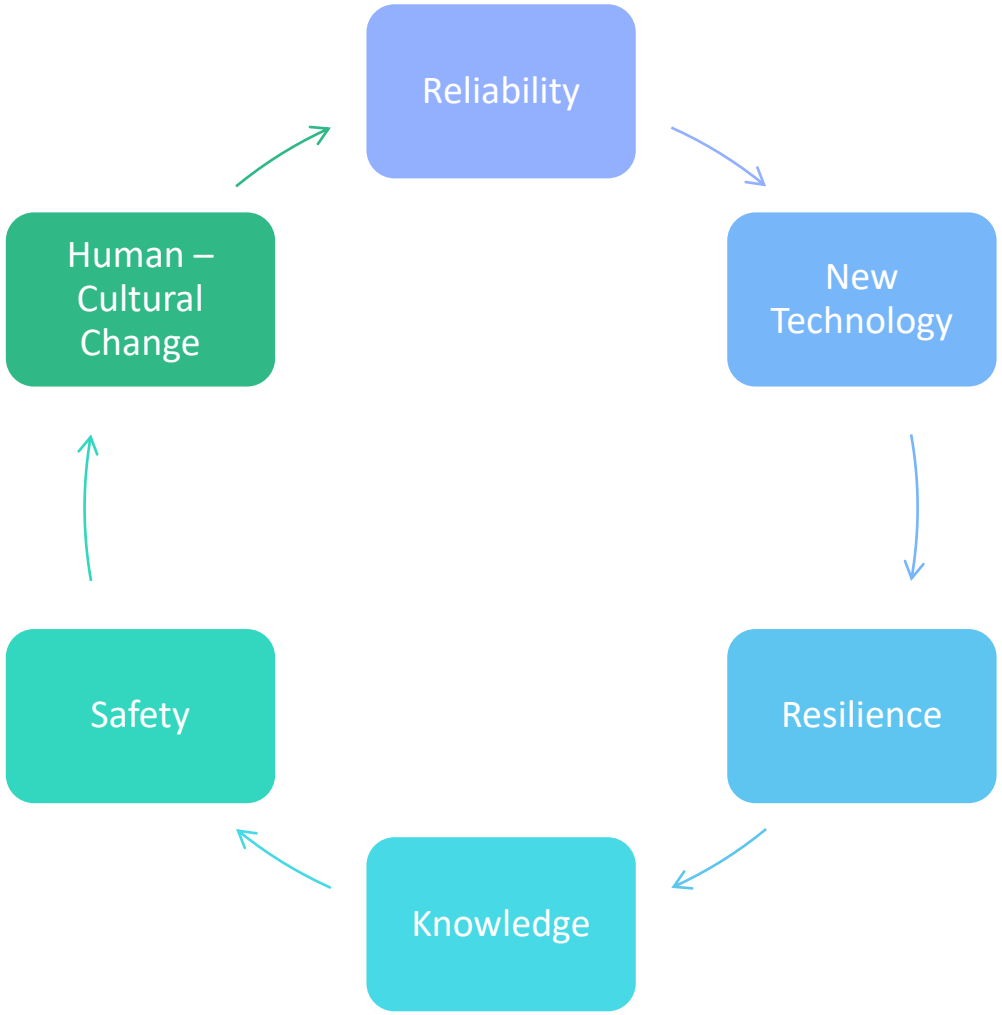
Summary

Goals



- RAM Project: "a reliable plant is a safe and cost effective plant"

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Benefits

AVEVA PI System® Tools

- Better Governance Model:
  - Increased the effectiveness of support and maintenance;
  - Reduction of hours spent on creating new dashboards;
- System Integrator
- Data Infrastructure:
  - Single Data Source;
  - Better Relational Structure;
  - Better Data Analysis;
- System Standardization and Optimization

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Next Steps

Scope 2022/23

347 pieces of Equipment of categories:

- 203 Pumps
- 76 Agitators
- 2 Centrifugal
- 24 Compressors
- 27 Cooling Tower
- 15 Fans

Migration PI ProcessBook Screens to PI Vision Screen Solution

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