

Next-Gen Asset Management & Smart Equipment Maintenance

“AI and IoT in Predictive Maintenance: Maximizing Efficiency and Equipment Lifespan in Container Terminals”

TMT
TRANS MISR
TERMINAL

EGMPT
— EGYPTIAN GROUP FOR —
MULTI PURPOSE TERMINALS

CMATERMINALS



TMT Terminal at a Glance



CMATERMINALS

Largest Multipurpose Terminal

Handles container, general cargo, and RoRo in **Alexandria, Egypt**.

Strong Strategic Alliance

Collaboration between **EGMPT** and **CMA Terminals**.

Government & Private Partnership

EGMPT is the commercial arm of **Egyptian Ministry of Transport**, **CMA Terminal** as global expertise.

Productivity with Our Cutting-Edge Equipment - Phase 1

STS Cranes
4 units

Reach Stackers
4 units

Yard Tractors
27 units

Ro-Ro Tractors
5 units

Breakbulk Trailers
8 units

Low Bed Trailers
2 units

E-RTG Cranes
12 units

Empty Handlers
3 units

Container Trailers
27 units

Forklifts

30 tons: 1 unit

7 tons: 1 unit

3 tons: 9 units



Introduction: Scope of Maintenance - Objectives



Minimize Asset Sudden Breakdown



Increase Asset Life



Optimize Asset Performance



Decrease Maintenance Expenses



- Transforming Maintenance with AI in Container Terminals.



AI: Smarter Maintenance for Terminals:

- Predictive AI prevents equipment failures.
- Boosts **CHE** performance (reliability, lifespan, efficiency).
- TMT Terminal is leveraging AI to optimize.
- Reduces downtime & costs, critical for modern terminal operations.

Maintenance Strategies Chart

Maintenance

Unplanned Maint.

Corrective Maint.

Breakdown Maint.

Planned Maint.

Preventive Maint.

Usage Based Maint.

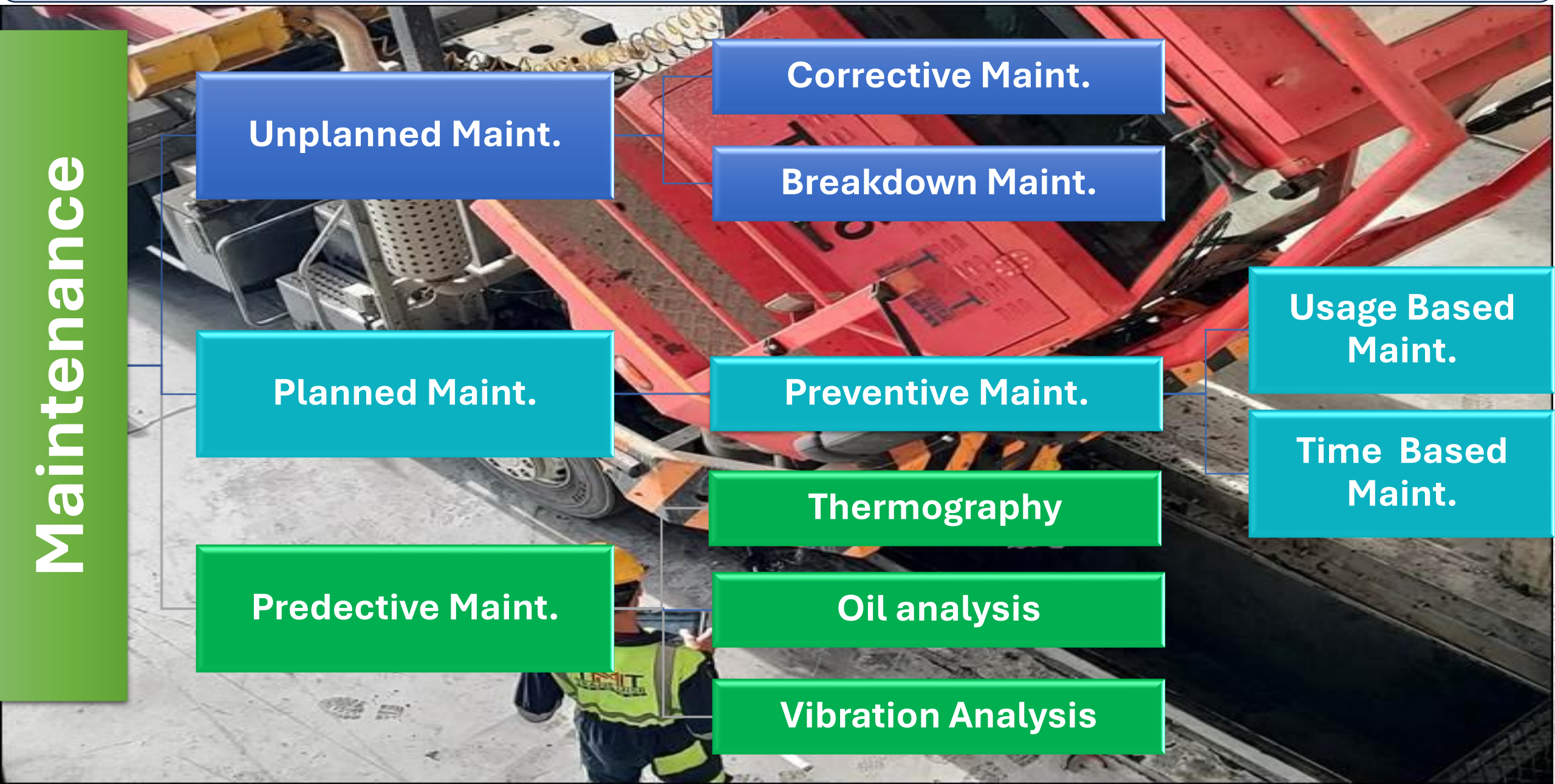
Time Based Maint.

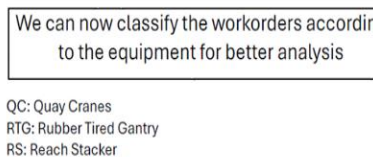
Predictive Maint.

Thermography

Oil analysis

Vibration Analysis



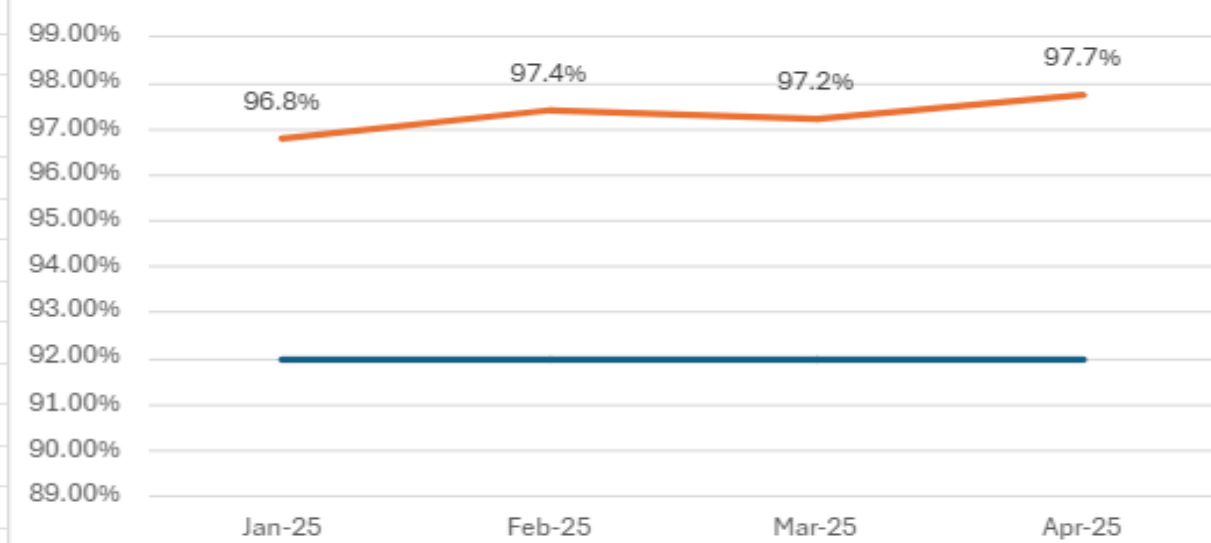


Data Analysis and Continuous Improvement

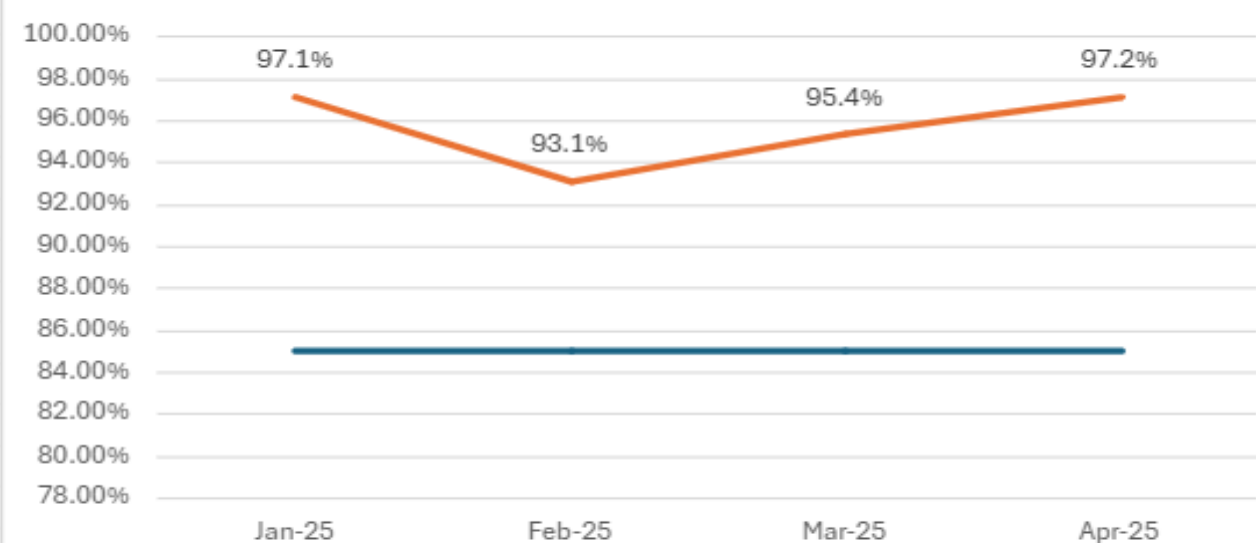


Equipment KPIs: Availability and MMBF

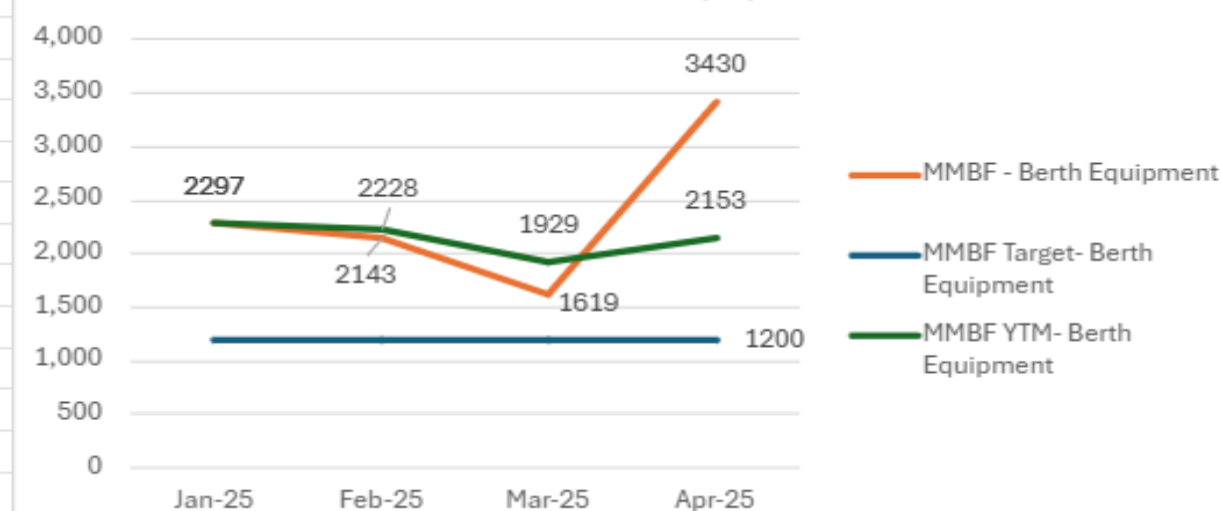
Availability - Berth Equipment (%)



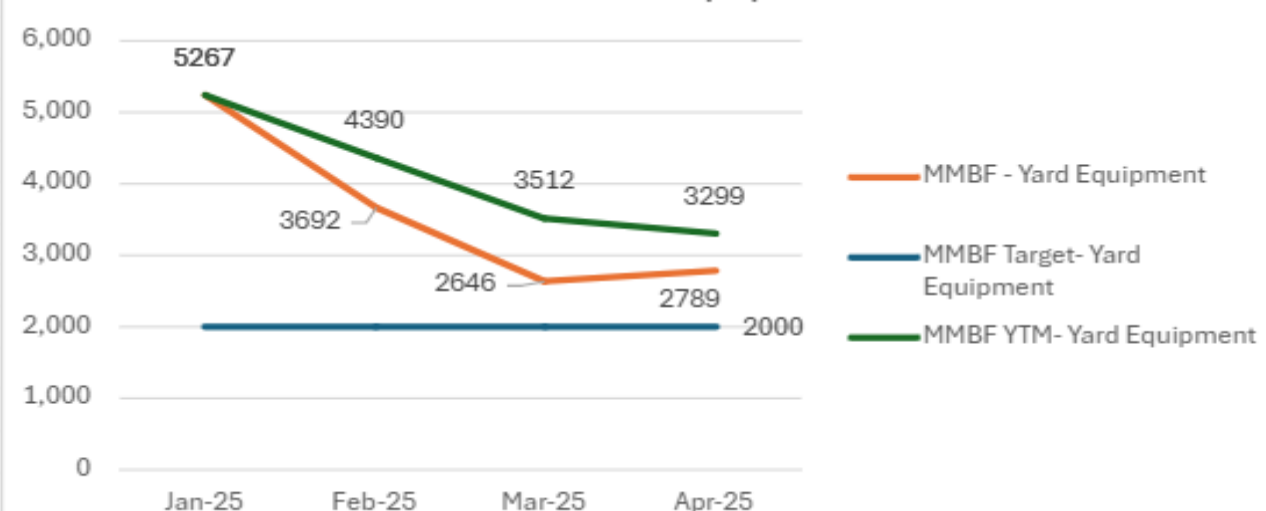
Availability - Yard Equipment (%)

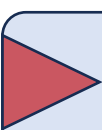


MMBF - Berth Equipment



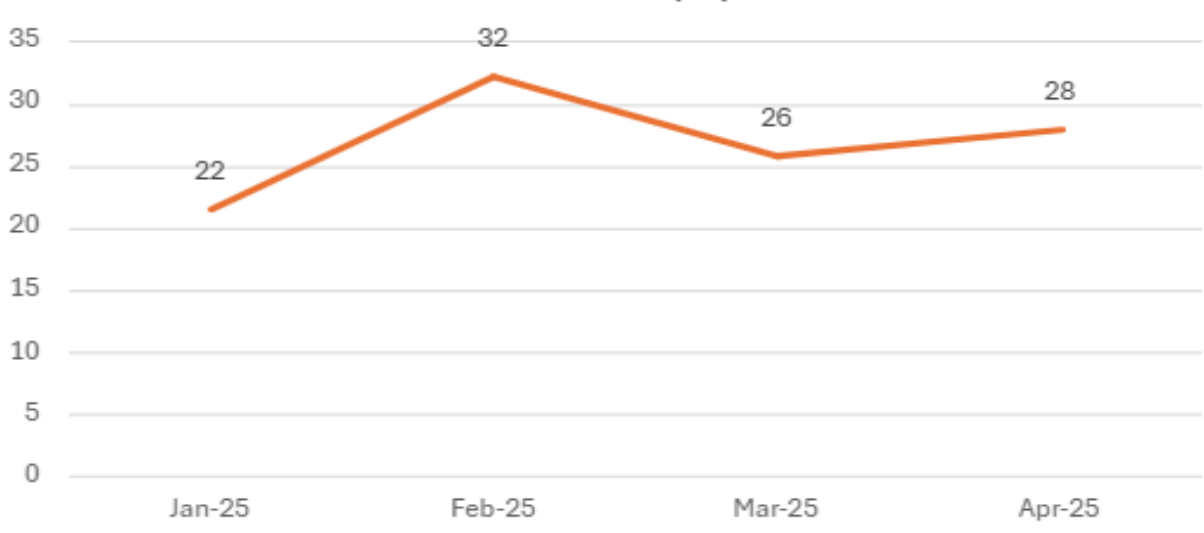
MMBF - Yard Equipment



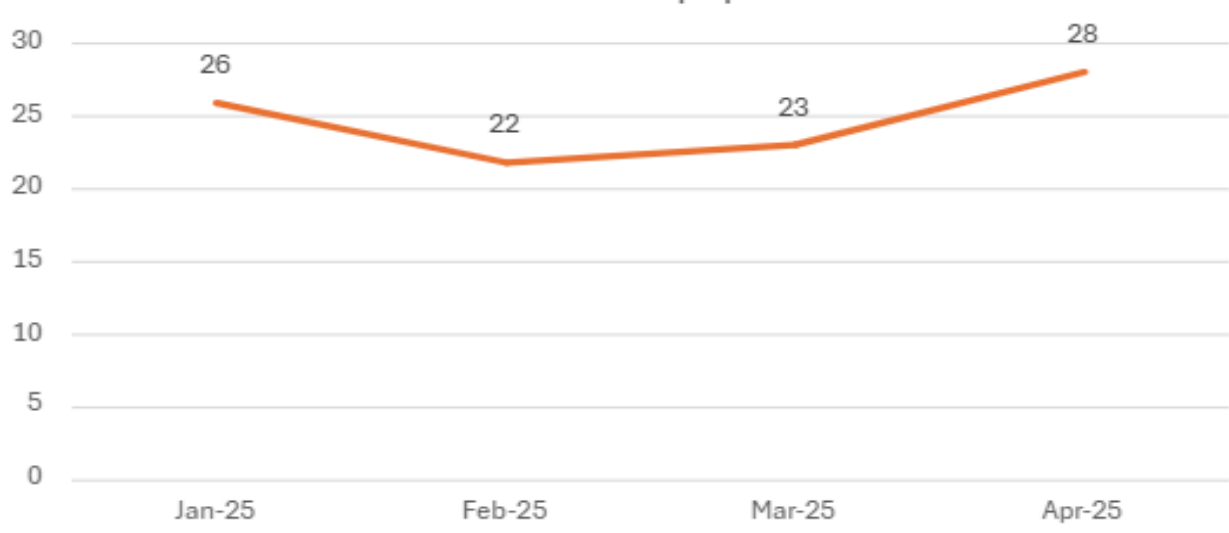


Equipment KPIs: MTTR and Utilization

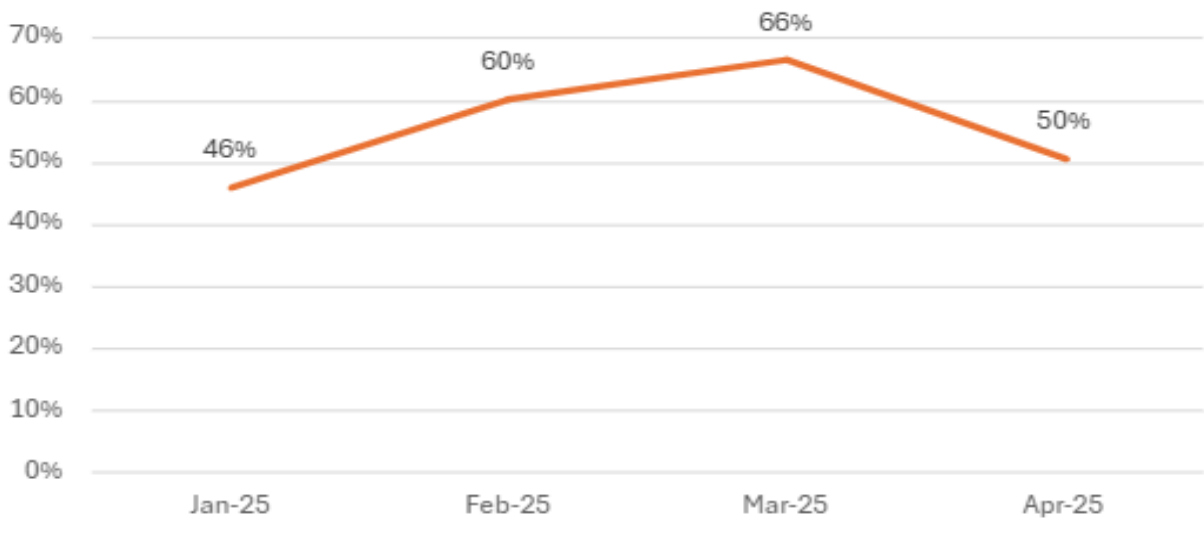
MTTR - Berth Equipment



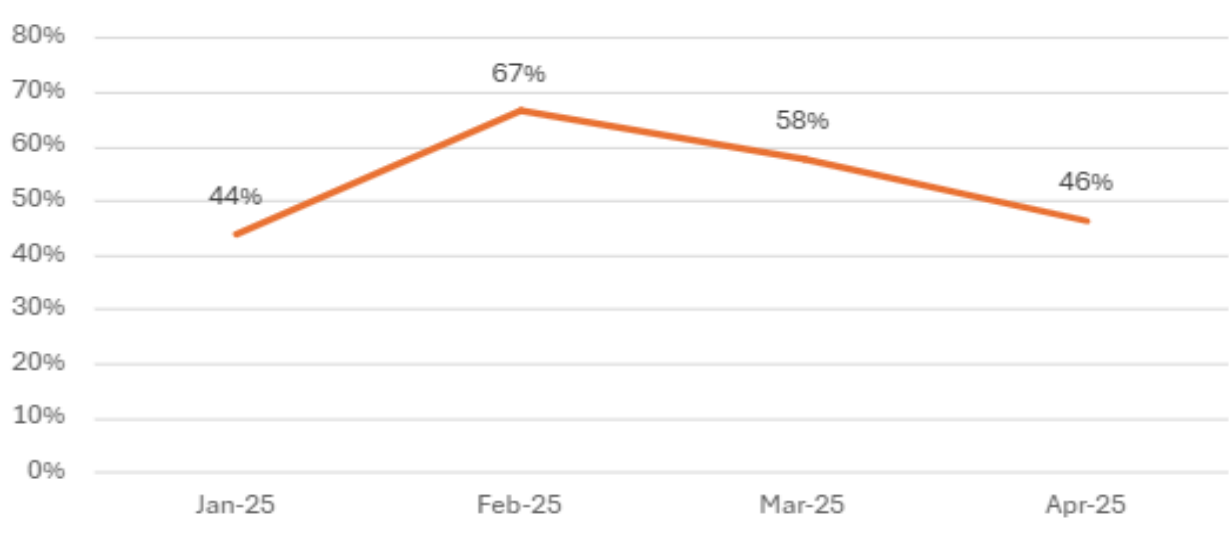
MTTR - Yard Equipment



Utilization - Berth Equipment (%)



Utilization - Yard Equipment (%)



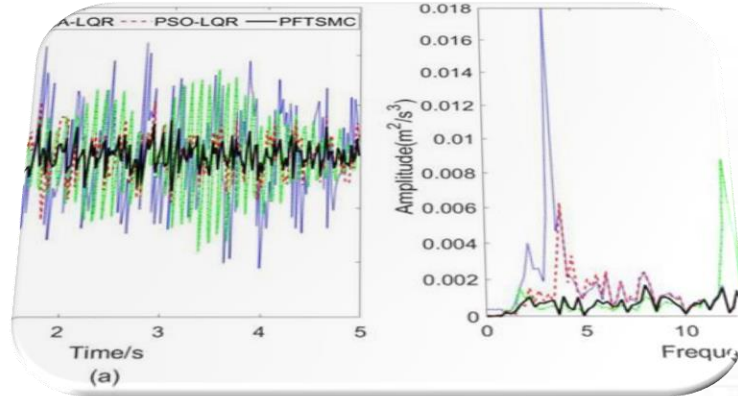
What Is Predictive Maintenance?

See, Hear, Analyze
Prevent

Important Tools For Predictive Maintenance:



Thermography



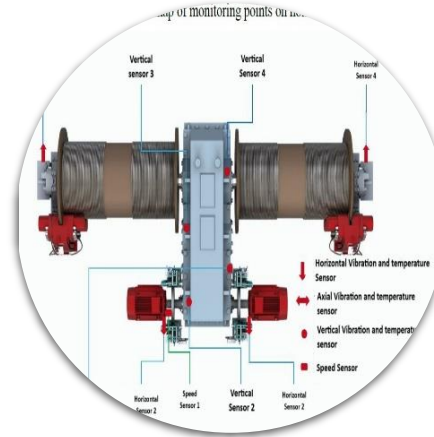
Vibration Analysis



Oil Analysis



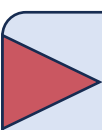
Thermal Camera



Vibrational Analysis



Oil Sampling Analysis



The Role of IoT in Predictive Maintenance

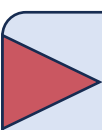
Smarter Cranes through IoT-Driven Predictive Maintenance Transforming Maintenance with IoT & AI:



IoT and Ship to Shore Cranes

Cranes → Sensors → Data Cloud → AI/Analytics → Predictive Maintenance Decision





The Role of IoT in Predictive Maintenance

Choose > EGMP > STS > STS03 > Hoist Drive Mechanism

Hoist 1#motor 1#vib
— , 27°C

Hoist 2#motor 2#vib
— , 28°C

Hoist gearbox 1#vib
— , 44°C

Hoist gearbox 2#vib
— , 47°C

Hoist gearbox 3#vib
— , 45°C

Hoist gearbox 4#vib
— , 46°C

Hoist 1#drum 1#vib
— , 23°C

Hoist 2#drum 2#vib
— , 23°C

Hoist 1#brake 1#vib
— , 26°C

Hoist 2#brake 2#vib
— , 26°C

Phase difference spectrum

Complementary power

Hoist Motor 1

Hoist Motor 1 Thermography

Hoist Gear 1 box vibration

Hoist Gear box 1 oil analysis

Hoist output shaft

Route Spectrum: 22-Apr-13 17:54:03
OVERALL: 0.057 V-DOS
PK = 0.060
LOAD = 100.0
RPM = 3570 (59.50 Hz)
V-SK7 231/0EAP
O-08Y1-BH

Freeq: 27.34
Orb: 7.657
Spec: 0018E

status by years

REPORTS	OK	WARN	ERR	NO STATUS	TOTAL
2014	10	100	0	100	210
2015	10	100	0	100	210
2016	10	100	0	100	210
2017	10	100	0	100	210
2018	10	100	0	100	210

Confirm Results



Identified Failure
broken Tooth

Random Testing
10 Times

AI Diagnostics



Only allow generate
results in **30s**

Blind Test



Each case only allows
1 min measurements



1. Partial Oil

2. Bearing Failure

3. Brand New

4. Broken Tooth

5. Without Oil

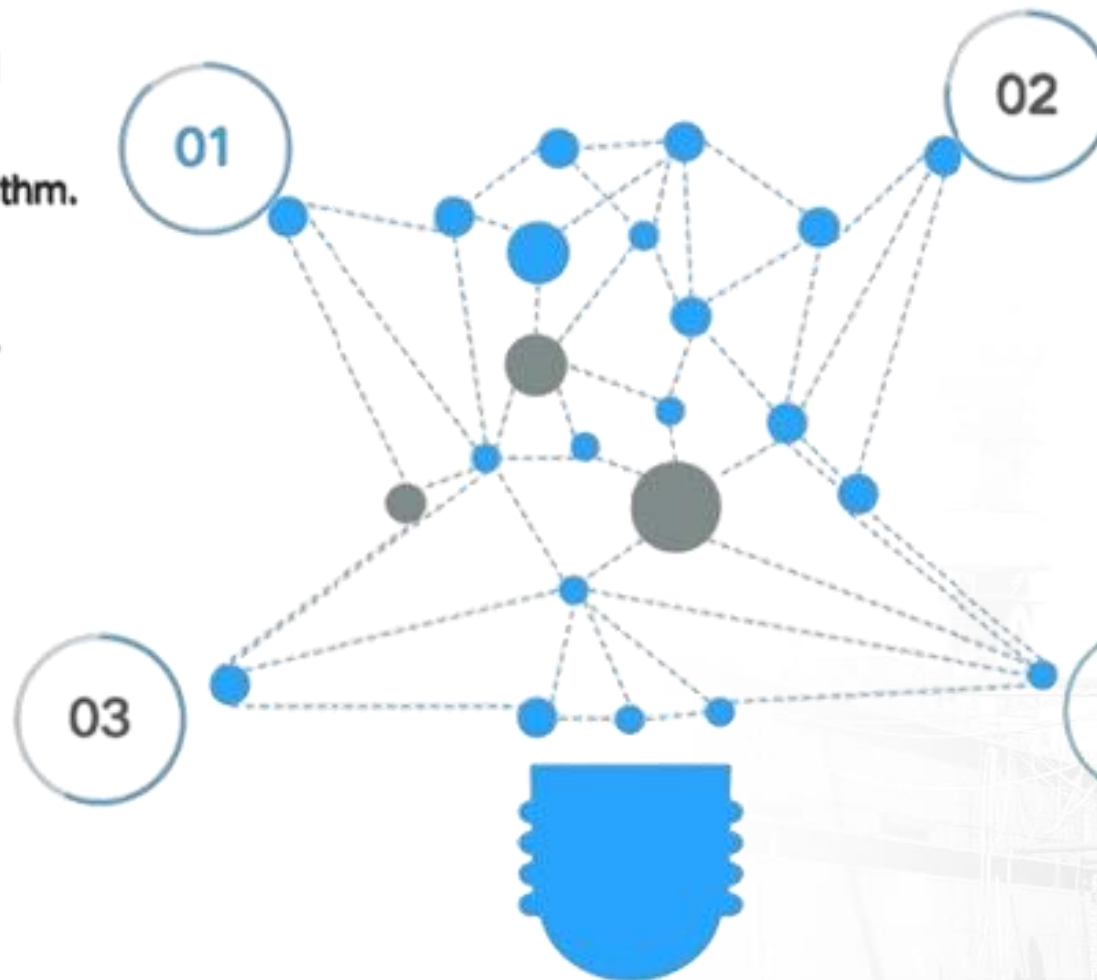
Automatic Diagnostics

Failure Mechanism Model

Turn the experience of a diagnostic expert into an algorithm.
Gear fault;
Bearing fault;
Motor's rotor and stator fault.

Trendancy Anlysis Model

30+ fault characteristic indicators;
Evaluation of deterioration;
TrendTrendancy Analysis.



Machine Learning Model

The amount of historical data collected is greater than 30Tb.
Machine learning algorithm modeling;
Fault feature identification.

Auto-diagnosis Conclusion

Intelligent fault identification;
Potential failures and their probabilities;
Corresponding maintenance proposal.

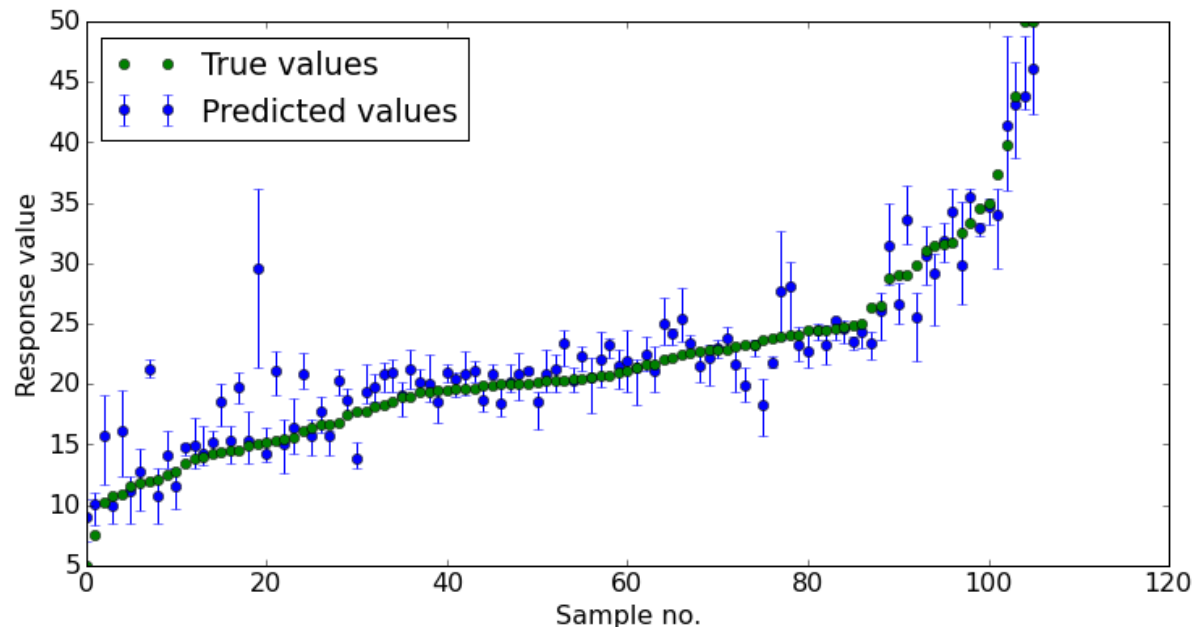
Random Forest: The Prediction Engine

- **Concept:** An ensemble of multiple decision trees (h_k).
- **Function:** Predicts an outcome $\hat{y}$ from IoT features x .
 - **Example (Regression for "Time to Failure"):** $\hat{y}(x) = M1$ (where M is the number of trees)

$$\hat{y}(x) = \frac{1}{M} \sum_{k=1}^M h_k(x)$$

Quantifying Uncertainty: Prediction Intervals

- **Beyond $\hat{y}$:** We provide a **Prediction Interval** [PL,PU] to show the probable range of the true outcome.
- **Benefit:** Enables proactive, risk-aware maintenance scheduling and builds trust.



Graph: Visualizing Predictions & Uncertainty

- **Green Dots:** True (Actual) Values.
- **Blue Dots:** Random Forest Point Predictions.
- **Blue Vertical Bars:** Prediction Intervals (The "**Uncertainty**").
- **Interpretation:** The length of the bar shows our confidence. Shorter bars = more confident predictions. Ideally, the green dot falls within the blue bar.

Overall Equipment Effectiveness (OEE)

LESS THAN 50%



Reactive

Fix when
broken

50% TO 75%



Planned

Scheduled
maintenance
activity

75 TO 90%



Proactive

Defect
elimination
to improve
performance

MORE THAN 90%



Predictive

Advanced analytics
and sensing data
to
predict machine
reliability

Thank You





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