Paper Summary

<!--META_START-->

Title: An Open-Source Tool-Box for Asset Management Based on the Asset Condition for the Power Syst

Authors: Gopal Lal Rajora, Miguel A. Sanz-Bobi, Carlos Mateo Domingo, Lina Bertling Tjernberg

DOI: 10.1109/ACCESS.2025.3551663

Year: 2025

Publication Type: Journal

Discipline/Domain: Electrical Engineering / Power Systems

Subdomain/Topic: Asset Management, Predictive Maintenance, Machine Learning for Power Grids

Eligibility: Eligible

Overall Relevance Score: 90

Operationalization Score: 95

Contains Definition of Actionability: Yes (implicit and explicit operational framing)

Contains Systematic Features/Dimensions: Yes

Contains Explainability: Partial

Contains Interpretability: Yes

Contains Framework/Model: Yes

Operationalization Present: Yes

Primary Methodology: Conceptual + Quantitative Case Study

Study Context: European ATTEST project; predictive maintenance for TSOs and DSOs

Geographic/Institutional Context: Spain (Universidad Pontificia Comillas), Sweden (KTH), European partn

Target Users/Stakeholders: Transmission System Operators (TSOs), Distribution System Operators (DS

Primary Contribution Type: Framework + Open-source Tool

CL: Yes

CR: Yes

FE: Yes

TI: Yes

EX: Partial

GA: Yes

Reason if Not Eligible: n/a

<!--META_END-->

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An Open-Source Tool-Box for Asset Management Based on the Asset Condition for the Power System

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Discipline/Domain:

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Subdomain/Topic:

Asset Management, Predictive Maintenance, Machine Learning for Power Grids

Contextual Background:

Developed under the European ATTEST project, the toolbox targets proactive asset management for ele

Geographic/Institutional Context:

Spain (Universidad Pontificia Comillas), Sweden (KTH Royal Institute of Technology), EU partners.

Target Users/Stakeholders:

Transmission and Distribution System Operators.

Primary Methodology:

Conceptual framework with quantitative case study (real-world and synthetic datasets).

Primary Contribution Type:

Modular open-source software integrating AI-based analytics for asset condition assessment and strateg

General Summary of the Paper

The paper introduces an open-source asset management toolbox designed for TSOs and DSOs, integrat

Eligibility

Eligible for inclusion: **Yes**

How Actionability is Understood

The paper explicitly links “actionable insights” to the ability to inform prioritized, effective maintenance str

> “The toolbox provides actionable insights for planning maintenance strategies and optimizing resource

> “Each asset’s condition is evaluated… facilitating effective prioritization and decision-making for mainte

What Makes Something Actionable

- Measurable condition indicators across four dimensions: Life Assessment, Health Condition, Maintenan
- Ability to compare across heterogeneous assets.
- Prioritization thresholds for intervention.
- Integration of predictive analytics (clustering + SOM) for early identification of risks.
- Strategy recommendation system (Q-learning) that adapts to changes without manual rule rewriting.

How Actionability is Achieved / Operationalized

- **Framework/Approach Name(s):** ATTEST Asset Management Toolbox
- **Methods/Levers:** Data normalization, clustering (K-means, SOM), condition indicator computation, re
- **Operational Steps / Workflow:**
  1. Identify critical asset data.
  2. Compute multi-dimensional condition indicators.
  3. Cluster assets for pattern recognition.
  4. Apply Q-learning to recommend optimal actions.
  5. Simulate long-term strategies (Monte Carlo).
- **Data & Measures:** Asset age, failure probability, internal temperature, dissolved gas analysis, MTTR
- **Implementation Context:** Tested on European TSO/DSO datasets; compatible with CIM, IEC 61850,

> “This Module compares assets… recommending the most convenient actions… simulate and quantify t

> “The Q-learning algorithm… suggests actions with the highest potential reward.” (p. 8)

Dimensions and Attributes of Actionability (Authors’ Perspective)

- **CL (Clarity):** Yes — Explicit, interpretable indicators for each dimension.
  > “Comparable condition indicators… allowing identification of assets requiring special attention.”
- **CR (Contextual Relevance):** Yes — Indicators adaptable to available data and operational context.
- **FE (Feasibility):** Yes — Prioritized strategies feasible given operational constraints.
- **TI (Timeliness):** Yes — Short-term and long-term analyses inform timely interventions.
- **EX (Explainability):** Partial — While results are interpretable, underlying ML models’ inner workings a
- **GA (Goal Alignment):** Yes — Optimizes for reliability, cost-efficiency, and sustainability goals.
- **Other Dimensions:** Adaptability (tool modularity and format compatibility).

Theoretical or Conceptual Foundations

- Condition-based maintenance theory.
- AI/ML for predictive asset management.
- Reinforcement learning (Q-learning) for adaptive strategy optimization.
- Multi-criteria decision analysis.

Indicators or Metrics for Actionability

- Multi-dimensional condition indicators (0–1 scale).
- Total Indicator threshold (e.g., >0.75 for critical attention).
- Cluster patterns denoting asset health states.

Barriers and Enablers to Actionability

- **Barriers:** Data incompleteness, heterogeneity of formats, variability in monitoring availability.
- **Enablers:** Open-source modular design, integration with industry standards, compatibility with multip

Relation to Existing Literature

Positions itself as advancing AI-driven asset management from descriptive analytics to prescriptive decis

Summary

The paper offers a comprehensive, modular, open-source framework for transforming raw asset condition

Scores

- **Overall Relevance Score:** 90 — Clear conceptualization of actionability through explicit condition-bas
- **Operationalization Score:** 95 — Detailed, replicable methodology with workflow, algorithms, metrics,

Supporting Quotes from the Paper

- “The toolbox provides actionable insights for planning maintenance strategies and optimizing resource a
- “Comparable condition indicators… allowing identification of assets requiring special attention.” (p. 6)
- “Optimal actions are determined using a Q-matrix… suggests actions with the highest potential reward.”
- “Assets are categorized as requiring priority attention and maintenance when the Total Indicator is nearl

Actionability References to Other Papers

- Rajora et al. (2024) — AI-based ML models for asset management.
- Žarkovi■ et al. (2021) — ML for transformer diagnostics.
- Li et al. (2023) — ML + blockchain in power management.
- Aminifar et al. (2022) — ML for asset management and protection.