A Comprehensive Review of Maintenance Strategies: From Reactive to Proactive Approaches

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Abstract

Maintenance strategies have evolved considerably, transitioning from reactive approaches to proactive methodologies. In this paper we investigate papers and compare different approaches and clarify what maintenance strategy more noticed and why. We are seeking to answer this question. A systematic review of 38 peer-reviewed paper will be conducted to identify which strategies are most commonly used. This study systematically reviews two primary branches of maintenance—reactive (corrective) and proactive (preventive and predictive) strategies—through a comprehensive analysis of academic literature. A structured collection of peer-reviewed papers was compiled from Scopus, Web of Science, and IEEE Xplore, using targeted keywords such as "maintenance strategy," "maintenance management," "reliability," and specific approaches ("Preventive Maintenance," "Condition-Based Maintenance," "Predictive Maintenance"). Our findings reveal that reactive maintenance, while simple and low-cost, often results in unplanned downtime and higher long-term expenses. In contrast, proactive methods (e.g., scheduled maintenance, condition-based monitoring) significantly improve operational efficiency, reduce failures, and optimize lifecycle costs. The evidence suggests that proactive strategies are the superior choice for industries where reliability and cost-effectiveness are critical.

Keywords: Maintenance Strategies, Reactive Maintenance, Preventive Maintenance, Predictive Maintenance (PdM), Asset Management, IOT, Industry 4.0, Machine learning.

Introduction

Effective maintenance strategies form the backbone of industrial reliability, directly influencing operational continuity, safety standards, and financial performance across sectors such as manufacturing, energy, and transportation. Historically, organizations relied on reactive maintenance—addressing equipment failures only after they occurred—due to its simplicity and minimal upfront costs. However, the limitations of this approach, including unplanned downtime, escalating repair expenses, and heightened safety risks, spurred the adoption of preventive methodologies. These time- or usage-based strategies aimed to mitigate failure risks through scheduled inspections, part replacements, and lubrication. While preventive maintenance reduced catastrophic breakdowns, its rigid scheduling often led to over-maintenance, unnecessary part replacements, and inefficiencies in resource allocation.

The advent of Industry 4.0 marked a paradigm shift in asset management, driven by advancements in sensor technology, IoT connectivity, and machine learning. Predictive maintenance (PdM) emerged as a transformative approach, leveraging real-time data analytics to forecast equipment failures with unprecedented accuracy. By continuously monitoring parameters such as vibration, temperature, and acoustic emissions, PdM enables precise identification of early-stage anomalies, allowing maintenance teams to intervene proactively—before malfunctions escalate into costly breakdowns. This data-centric approach not only minimizes downtime but also optimizes spare parts inventory, reduces energy consumption, and extends asset lifespans. For example, in the wind energy sector, PdM has reduced turbine maintenance costs by up to 25% through early detection of bearing wear and gearbox issues (Zhang et al., 2021).

Cloud computing facilitates scalable data storage and analysis, while edge computing enables real-time processing at the source of data generation. Machine learning algorithms, trained on historical and real-time operational data, can predict failure modes with over 90% accuracy in controlled environments (Kandukuri et al., 2019). These advancements have positioned PdM as a cornerstone of modern asset management, particularly in capital-intensive industries like aerospace and oil refining, where unplanned downtime can incur losses exceeding $500,000 per hour (McKinsey & Company, 2020).

Despite its advantages, PdM implementation faces challenges, including high initial costs, data integration complexities, and the need for specialized expertise. Organizations must invest in sensor networks, data infrastructure, and workforce training to fully realize PdM's potential. Moreover, the effectiveness of PdM hinges on the quality of data and the robustness of predictive models, necessitating continuous model refinement to account for evolving operational conditions.

This review systematically examines the evolution of maintenance strategies from reactive to proactive frameworks, evaluating their technical, economic, and operational implications. By synthesizing empirical studies, industry case examples, and emerging trends, this article aims to provide practitioners with actionable insights for selecting and implementing maintenance strategies aligned with organizational goals and technological readiness.

Literature Review

A substantial body of research has examined the evolution and effectiveness of maintenance strategies, ranging from reactive to proactive approaches. Early literature primarily focused on the development and optimization of maintenance management systems, emphasizing the need for structured decision-making and the integration of various maintenance techniques to improve operational efficiency and asset reliability. Garg and Deshmukh (2006) provided a comprehensive review of maintenance management literature, highlighting the shift from traditional reactive practices to more systematic and proactive strategies, such as preventive and condition-based maintenance. Their analysis underscored the importance of optimization models, scheduling, and information systems in advancing maintenance management.

Further studies expanded on the classification and impact of different maintenance strategies. Goyal et al. (2012) conducted a retrospective review, categorizing maintenance management practices into distinct areas and sub-areas. Their work identified emerging trends, such as the adoption of risk-based and reliability-centered maintenance, and emphasized the growing relevance of data-driven approaches in maintenance decision-making. This classification has helped practitioners and researchers better understand the strengths and limitations of each strategy, as well as the contextual factors influencing their selection and implementation.

Recent literature has increasingly focused on the formulation, selection, and implementation of maintenance strategies within industrial contexts like Firdaus et al. (2023) systematically reviewed maintenance strategies with a particular emphasis on energy efficiency, categorizing them as inspection-based (IBM), time-based (TBM), and condition-based maintenance (CBM). Their findings indicate that while IBM relies on human judgment for fault detection, TBM and CBM leverage historical and real-time data, respectively, to optimize maintenance timing and effectiveness. The study also highlighted the growing importance of CBM and predictive maintenance, particularly in industries seeking to align with ISO 50001 energy management standards.

Additionally, the development of conceptual frameworks for maintenance strategy selection has been a key area of interest. Research by Parida et al. (2015) synthesized existing literature to propose frameworks that guide organizations in formulating, selecting, and implementing maintenance strategies tailored to their operational needs. These frameworks emphasize the logical relationship between strategy formulation, selection, and execution, and underscore the impact of maintenance strategy on overall maintenance function and organizational performance

Methodology

This paper conducts a review of academic literature focusing on maintenance strategies. A comprehensive collection of 38 papers (from 1997 – 2023) was compiled through databases such as Scopus, Web of Science, and IEEE Xplore, using keywords related to "maintenance strategy," "maintenance management," "reliability," and specific maintenance approaches (e.g., "Preventive Maintenance," "Condition-Based Maintenance," "Predictive Maintenance").

The selected papers were analyzed to identify the maintenance strategies discussed and their relationships. A summary table was created (Table 1) to categorize each paper based on the maintenance strategies it addresses. The strategies considered include Corrective Maintenance (CM), Preventive Maintenance (PM), Predictive Maintenance (PdM), Condition-Based Maintenance (CBM), Reactive Maintenance, Proactive Maintenance, Planned Maintenance, Unplanned Maintenance, Total Productive Maintenance (TPM), and Design-out Maintenance. A checkmark (√) indicates that the paper explicitly discusses or focuses on that particular maintenance strategy. This method allows for a structured overview of the prevalence and focus of different maintenance strategies within the academic literature.

Summary of academic papers by maintenance strategy	**CM**	**PM**	**PdM**	**CBM**	**Reactive**	**Proactive**	**Planned**	**Unplanned**	**TPM**	**Design-out**
Al-Najjar, et al., (2003)		√								
Arslankaya, et al. (2015)		√	√				√		√	√
Asuquo, M. P., et al. (2019)		√	√	√						
Bashiri M. et al. (2011)	√	√	√	√						
Bevilacqua, et al.. (2000)	√	√	√	√						
Borissova D. I. et al. (2012)		√	√	√						
Cherkaoui, H. et al. (2016)										
Eti, M. C. et al. (2006)	√	√	√	√						
Horner, R.M.W., et al. (1997)	√									
Ierace, S. et al. (2008)	√	√	√	√						
Ioannis, D. et al. (2013)	√	√	√	√						
Lee, H. et al. (2008)	√	√	√	√						

Legát, V. et al. (2017)	√	√	√							
Lind, H. et al. (2012)	√									
Mikler, J. (2011)		√								
Mostafa, S., et al. (2015)										√
Murthy, D. et al. (2002)	√	√	√							
Ni, X. et al. (2016)		√								
Okoh, C. et al. (2017)		√		√						
Ollila, A. et al.(1999)		√		√						
Özcan, E.C. et al. (2017)		√		√						
Rani, N. et al. (2015)	√	√	√	√						
Sambrekar, A. et al. (2018)		√		√						
Shafiee, M. (2015)		√		√						
Sharma, R. et al. (2015)		√	√	√						
Shin, J.-H. et al. (2015)	√	√	√	√						
Srivastava, P. et al. (2017)		√		√						
Swanson, L. (2001)	√									
Teixeira, F. et al. (2016)										
Tu, J. et al. (2015)	√	√	√	√						
Velmurugan, R.S. et al. (2015)	√	√	√	√						

Vilarinho, S. et al. (2017)	√	√	√	√						
Vishnu, C. R. et al. (2016)	√	√		√						
Wang, L. et al. (2007)	√	√		√						
Zeng, Sh. W. (1997)	√	√								
Zhaoyang, T., et al. (2011)	√	√								
Zhang, Ch. et al. (2019)	√	√	√	√						

Table 1. **Summary of academic papers by maintenance strategy**

No.	Reference (Authors & Year)	Proposed Maintenance Strategy/Method
1	Al-Najjar & Alsyouf (2003)	Fuzzy Multiple Criteria Decision Making (MCDM) for optimal strategy selection
2	Arslankaya & Atay (2015)	Lean Maintenance integrated with Lean Manufacturing practices
3	Asuquo et al. (2019)	Multiple Attribute Group Decision Making (MAGDM) for marine equipment
4	Bashiri et al. (2011)	Fuzzy Interactive Linear Assignment for strategy selection
5	Bevilacqua & Braglia (2000)	Analytic Hierarchy Process (AHP) for strategy selection
6	Borissova et al. (2012)	Predictive Maintenance (PdM) with combinatorial optimization for sensor placement
7	Cherkaoui et al. (2016)	Condition-Based Maintenance (CBM) performance and robustness assessment
8	Eti et al. (2006)	Strategic maintenance management
9	Horner et al. (2002)	Building maintenance strategy with modern management approach
10	Ignat (2013)	Maintenance optimization based on CBM techniques
11	Ioannis & Nikitas (2013)	AHP and TOPSIS for ship maintenance strategy selection
12	Lee & Scott (2009)	Overview of maintenance strategies in building operations
13	Legát et al. (2017)	Preventive Maintenance (PM) models for higher operational reliability
14	Legutko (2009)	Trends in machinery operation and maintenance

15	Mikler (2011)	Life Cycle Costing (LCC) to justify transition to Predictive Maintenance
16	Mostafa et al. (2015)	Lean Maintenance Roadmap
17	Murthy et al. (2002)	Strategic maintenance management
18	Ni et al. (2016)	Nonlinear degradation modeling and maintenance policy (mathematical modeling)
19	Okoh et al. (2017)	Predictive Maintenance Modeling for through-life engineering services
20	Ollila & Malmipuro (1999)	Maintenance's role in quality management
21	Özcan et al. (2017)	Combined Goal Programming, AHP, and TOPSIS for hydroelectric plants
22	Pająk & Woropay (2009)	Maintenance strategy based on controlled consumption of operational potential
23	Rani et al. (2015)	Perception of maintenance management in healthcare facilities
24	Sambrekar et al. (2018)	Overview of maintenance strategies for Industry 4.0
25	Shafiee & Sørensen (2017)	Maintenance optimization and inspection planning for wind assets
26	Shafiee (2015)	MCDM overview for maintenance strategy selection
27	Sharma et al. (2005)	Fuzzy Logic Model (FLM) and MISO model for strategy selection
28	Shin & Jun (2015)	Condition-Based Maintenance (CBM) policy
29	Srivastava et al. (2017)	Fuzzy integrated MADM and GMA for agile maintenance strategy selection
30	Tan et al. (2011)	Risk-Based Inspection (RBI) for maintenance strategy evaluation
31	Teixeira & Junior (2016)	Probabilistic Condition-Based Maintenance (PCBM) using structural reliability
32	Tu et al. (2015)	Maintenance strategy decision for avionics based on cognitive uncertainty
33	Velmurugan & Dhingra (2015)	Conceptual framework for strategy selection and its impact
34	Vilarinho et al. (2017)	Preventive Maintenance decisions via optimization models
35	Vishnu & Regikumar (2016)	Reliability-Based Maintenance strategy selection
36	Wang et al. (2007)	Fuzzy Analytic Hierarchy Process (AHP) for optimal strategy selection
37	Zeng (1997)	Discussion on maintenance strategies, policies, and systems
38	Zhang et al. (2019)	Opportunistic Maintenance for wind turbines considering weather and inventory

Table 2. Maintenance Strategies Proposed in the Reviewed Articles

Maintenance Strategy/Method	Number of Articles
Multi-Criteria Decision Making (MCDM, AHP, TOPSIS, etc.)	10
Condition-Based Maintenance (CBM, PCBM)	5
Predictive Maintenance (PdM)	5
Preventive Maintenance (PM)	4
Maintenance Optimization/Mathematical Models	4
Strategic/Other (e.g., management, quality, trends)	4
Reliability-Based Maintenance	2
Lean Maintenance	2
Opportunistic Maintenance	1
Risk-Based Inspection (RBI)	1

Table 3. Main Maintenance Strategies Suggested in Reviewed Articles

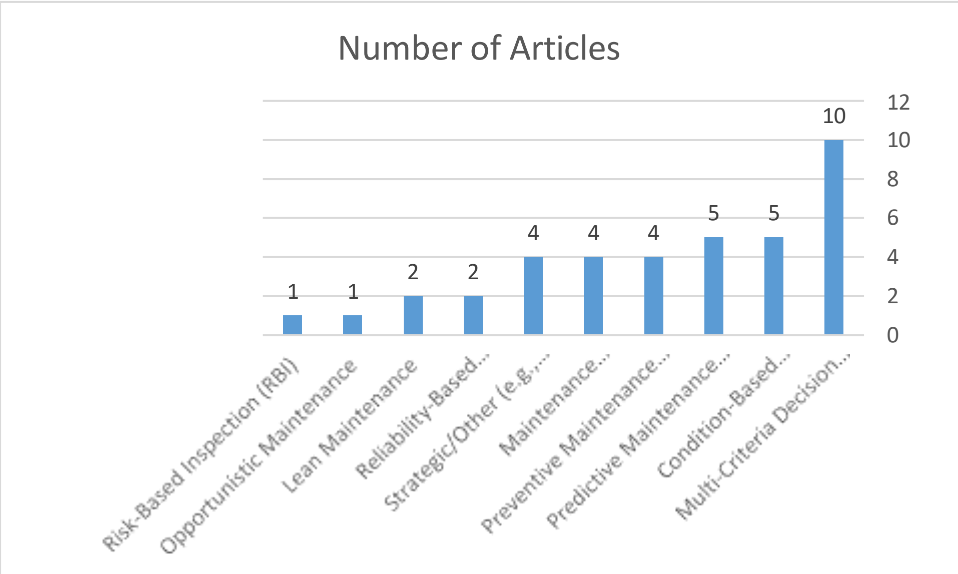

Chart 1. Suggested approaches on base of papers

Summary & Insights

Multi-Criteria Decision Making (MCDM, AHP, TOPSIS, etc.) is the most commonly used approach for selecting the optimal maintenance strategy, appearing in 10 articles.

Condition-Based Maintenance (CBM/PCBM) and **Predictive Maintenance (PdM)** are also highly prevalent, each discussed in 5 articles.

Preventive Maintenance (PM) and **Maintenance Optimization/Mathematical Models** are significant; each featured in 4 articles.

Newer approaches such as **Lean Maintenance** and **Opportunistic Maintenance** are emerging but less common.

Other strategies include Risk-Based Inspection (RBI), Reliability-Based Maintenance, and various strategic/managerial perspectives.

Maintenance Strategies

1. Reactive Maintenance Strategies

Maintenance is performed only after equipment failure or performance degradation occurs.

Types:

- **Corrective Maintenance:**
    - Unplanned repairs for minor failures
    - Example: Replacing a burnt-out light bulb
- **Emergency Maintenance:**
    - Immediate response to critical failures causing production stoppage
    - Example: Repairing a broken water pump in production line

Advantages:

- Low initial cost
- No need for complex planning

Disadvantages:

- High failure costs
- Reduced equipment lifespan
- Production process interruptions

2. Proactive Maintenance Strategies

Aim to prevent failures before they occur.

Types:

- **Preventive Maintenance (PM):**
    - Scheduled maintenance based on time or usage
    - Example: Air filter replacement every 3 months
- **Condition-Based Maintenance (CBM):**
    - Continuous monitoring and maintenance based on real-time data
    - Example: Bearing replacement based on vibration analysis
- **Multi-Criteria Decision Making (MCDM) in Maintenance:**
    - Structured framework for evaluating trade-offs between conflicting objectives
    - Example: Using AHP to select optimal maintenance strategy weighing cost (45%), safety (30%), and downtime (25%)
- **Predictive Maintenance (PdM):**
    - Failure prediction using AI and data analytics

   - Example: Compressor failure prediction using machine learning
- **Reliability-Based Maintenance (RBM):**
   - Failure prevention using statistical reliability models
   - Example: Replacing refinery valves at 85% reliability threshold instead of fixed intervals
- **Lean Maintenance:**
   - Waste elimination in maintenance processes
   - Example: Reducing inventory costs by implementing just-in-time (JIT) spare parts management
- **Maintenance Optimization / Mathematical Models:**
   - Data-driven decision-making for maintenance planning
   - Example: Using genetic algorithms to optimize fleet maintenance schedules
- **Risk-Based Inspection (RBI):**
   - Asset integrity management prioritizing inspections by risk severity
   - Example: Focusing 80% of refinery pipe inspections on 20% high-risk corrosion zones
- **Opportunistic Maintenance (OM):**
   - Performing unplanned maintenance when an opportunity arises
   - Example: Replacing conveyor bearings during a scheduled production line stoppage

Advantages:

- Lower long-term maintenance costs
- Extended equipment lifespan
- Reduced unplanned downtime

Disadvantages:

- Requires initial investment
- Needs skilled personnel
- Complex implementation

Characteristics	Reactive	Proactive
Initial Cost	Low	High
Long-term Cost	High	Low
Production Stops	Frequent	Rare
Expertise Needed	Minimal	Significant
Best For	Non-critical equipment	Critical/expensive assets

Table 4. Maintenance Strategies

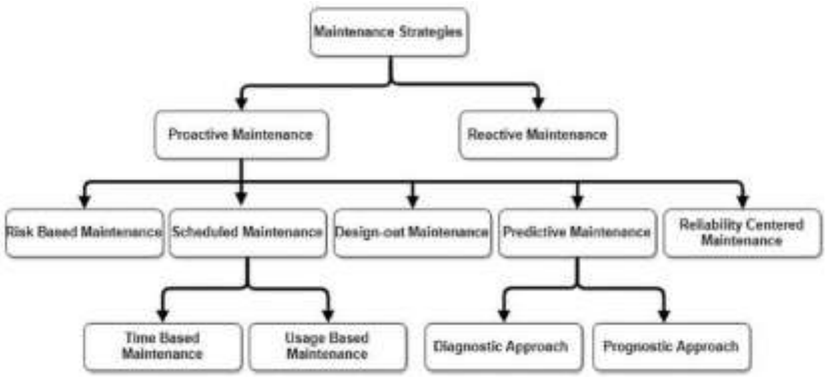

Fig. 1. Maintenance Strategies – Reactive & Proactive

Results

The choice of maintenance strategy depends on factors such as asset criticality, operational environment, available resources, and technological maturity. While reactive maintenance may be suitable for low-priority equipment, Proactive approaches are essential for critical systems where failures can lead to substantial financial or safety consequences. Predictive maintenance, in particular, is transforming asset management by enabling organizations to optimize maintenance schedules, reduce costs, and increase system availability through real-time monitoring and advanced analytics.

The analysis of academic papers reveals several key trends and insights regarding the focus and evolution of maintenance strategies. Based on the table (1), here's a threefold expansion of a typical discussion section:

1. Prevalence and Focus on Specific Maintenance Strategies

- **Preventive Maintenance (PM):** As shown in Table 1, PM is the most prevalent strategy with 31 mentions, Preventive Maintenance is the most frequently addressed strategy. This indicates a strong foundation in scheduled maintenance practices within the academic community. The high number suggests that researchers continue to explore and refine PM techniques, possibly focusing on optimizing intervals, reducing unnecessary interventions, and integrating it with other strategies.
- **Condition-Based Maintenance (CBM):** The significant presence of CBM (23 mentions) highlights the increasing importance of real-time monitoring and data-driven maintenance decisions. This reflects the growing availability and affordability of sensors, data analytics, and IoT technologies, enabling more sophisticated condition monitoring and proactive maintenance interventions.
- **Corrective Maintenance (CM):** Corrective Maintenance appears in 21 papers. Although it is by definition a reactive approach, its continued presence in academic discussions suggests an ongoing effort to understand failure modes, improve repair processes, and minimize downtime associated with unexpected breakdowns.
- **Predictive Maintenance (PdM):** Predictive Maintenance appears in 18 papers. This demonstrates the growing interest in advanced techniques for failure prediction. These techniques often involve sophisticated data analysis, machine learning, and AI to forecast potential failures.

Expanded Insight: The prominence of PM, CBM and PdM underscores a broader shift from reactive to proactive maintenance approaches, driven by the desire to minimize downtime, reduce costs, and improve asset reliability. The specific focus of research within each strategy likely varies, with some studies focusing on optimizing PM schedules, others on developing advanced CBM algorithms, and still others on refining PdM models for specific types of equipment.

2. Integration and Hybrid Approaches

- **Combined Strategies:** Many papers (e.g., Bashiri et al. (2011), Bevilacqua, et al. (2000), Ierace, S. et al. (2008)) discuss multiple maintenance strategies. This indicates a trend toward integrated or hybrid approaches, where different strategies are combined to optimize maintenance effectiveness. For example, a company might use PM for some assets, CBM for others, and PdM for critical equipment.

Expanded Insight: The integration of maintenance strategies reflects a more holistic approach to asset management, recognizing that no single strategy is universally optimal. The choice of strategy depends on various factors, including the criticality of the asset, the cost of downtime, the availability of data, and the expertise of the maintenance team. Research in this area likely focuses on developing frameworks and methodologies for selecting the optimal mix of strategies for different scenarios.

3. Emerging and Specialized Strategies

- **Total Productive Maintenance (TPM) and Design-Out Maintenance:** TPM and Design-Out Maintenance have limited mentions. The limited number of mentions suggests that these strategies might be less widely adopted or researched, or that they are often discussed within the context of other maintenance approaches.

Expanded Insight: The relatively low number of papers focusing on TPM and Design-Out Maintenance could indicate areas for future research. TPM, with its emphasis on employee involvement and continuous improvement, might be particularly relevant in industries with high labor costs or complex production processes. Design-Out Maintenance, which seeks to eliminate the need for maintenance through improved design, could be a valuable strategy for new equipment or systems.

4. Research Gaps and Future Directions

- **Limited Focus on Reactive Maintenance:** The absence of specific mentions of reactive maintenance as a primary focus suggests a potential gap in the literature. While reactive maintenance is often viewed as undesirable, it remains a reality in many organizations, particularly for non-critical assets.

Expanded Insight: Despite the move towards proactive strategies, reactive maintenance remains relevant. Further research could explore ways to optimize reactive maintenance processes, minimize downtime associated with unexpected failures, and develop decision support tools for determining when a reactive approach is appropriate. Additionally, more research could investigate the cultural and organizational factors that influence the adoption of different maintenance strategies, as well as the challenges and barriers to implementing proactive approaches

Conclusion

The analysis of academic literature confirms the growing focus on (proactive methods) predictive and condition-based maintenance, reflecting the increasing availability and sophistication of data-driven techniques. However, the continued presence of preventive and corrective maintenance in the literature underscores the importance of a balanced approach, where the choice of strategy is tailored to the specific asset, operational context, and organizational goals.

This paper presents a literature review of maintenance strategies and provide an overview of different authors concepts of maintenance strategies. In the analysis academic papers were considered to identify existing approaches to the topic. examples point out various maintenance types. Some of them are comparable, in some can we distinguish similarities, while some are clearly distinct, but all of theme suggest some approaches to reduce unplanned failures and increase running plant but the optimal approach depends on contextual factors like operator expertise, spare parts availability, financial problems and company priorities. repair team should, on base of research, experiment and their own organization's capabilities select an approach or combine some strategies and we suggest prioritize PdM for critical assets but balance it with PM or CBM based on cost-benefit analysis.

In some new works the integration of Industry 4.0 technologies presents both opportunities and challenges. While these technologies enable more effective maintenance strategies, they also require significant investments in data infrastructure, specialized expertise, and workforce training. Future research should focus on developing frameworks and methodologies for selecting and implementing the optimal mix of maintenance strategies, as well as addressing the challenges associated with data integration, model refinement, and organizational change management. The ultimate goal is to enable organizations to achieve higher levels of asset reliability, reduced costs, and improved operational efficiency through the strategic application of maintenance principles and technologies

REFEENCES

1) Al-Najjar, B. & Alsyouf, I. (2003). Selecting the most efficient maintenance approach using fuzzy multiple criteria decision making. International Journal of Production Economics, 84(1), pp. 85-100. doi: 10.1016/S0925-5273(02)00380-8.
2) Arslankaya, S. & Atay, H. (2015). Maintenance Management and Lean Manufacturing Practices in a Firm Which Produces Dairy Products. Procedia - Social and Behavioral Sciences, Elsevier B.V., 207, pp. 214-224. doi: 10.1016/j.sbspro.2015.10.090.
3) Asuquo, M. P. et al. (2019). Application of a multiple attribute group decision making (MAGDM) model for selecting appropriate maintenance strategy for marine and offshore machinery operations. Ocean Engineering, Elsevier Ltd, 179 (February), pp. 246-260. doi: 10.1016/j.oceaneng.2019.02.065.
4) Bashiri, M., Badri, H. & Hejazi, T. H. (2011). Selecting optimum maintenance strategy by fuzzy interactive linear assignment method. Applied Mathematical Modelling, Elsevier Inc., 35(1), pp. 152-164. doi: 10.1016/j.apm.2010.05.014.
5) Bevilacqua, M. & Braglia, M. (2000). Analytic hierarchy process applied to maintenance strategy selection. Reliability Engineering and System Safety, 70(1), pp. 71-83. doi: 10.1016/S0951-8320(00)00047-8.
6) Borissova, D., Mustakerov, I. & Doukovska, L. (2012). Predictive Maintenance Sensors Placement by Combinatorial Optimization. International Journal of Electronics and Telecommunications, 58(2), pp. 153-158. doi: 10.2478/v10177-012-0022-6.
7) Cherkaoui, H., Huynh, K. T. & Grall, A. (2016). On the Assessment of Performance and Robustness of Condition-Based Maintenance Strategies. IFAC-PapersOnLine, Elsevier B.V., 49(12), pp. 809-814. doi: 10.1016/j.ifacol.2016.07.874.
8) Eti, M. C., Ogaji, S. O. T. & Probert, S. D. (2006). Strategic maintenance-management in Nigerian industries. Applied Energy, 83(3), pp. 211-227. doi: 10.1016/j.apenergy.2005.02.004.
9) Gholipour, Y. (2022). Future of oil and renewable energy. Computational And Experimental Research In Materials And Renewable Energy, 5(1), 30-37. DOI: https://doi.org/10.19184/cerimre.v5i1.31492.
10) Gholipour, Y., Khani, N., Gholipour, Y. & Rokrok, M. (2025). The Effect of Timely Preventive Maintenance (PM) on Tourists' Satisfaction with Hotels. Indian Journal of Management and Language (IJML), 5(1), 44-48. DOI: 10.54105/ijml.I1816.05010425.
11) Horner, R. M. W., Haram, M. A. El & Munns, A. K. (2002). Building maintenance strategy: a new management. Journal of Quality in Maintenance Engineering, 3(4), pp. 273–280. Ierace, S. and Cavalieri, S. (2010). Maintenance Strategy Selection: a comparison between Fuzzy Logic and Analytic Hierarchy Process. IFAC Proceedings Volumes, IFAC. doi: 10.3182/20081205-2-cl-4009.00041
12) Ignat, S. (2013). Power Plants Maintenance Optimization Based on CBM Techniques. IFAC Proceedings Volumes, IFAC. doi: 10.3182/20130522-3-RO-4035.00031.
13) Ioannis, D. & Nikitas, N. (2013). Application of Analytic Hierarchy Process & TOPSIS methodology on ships' maintenance strategies. Journal of Polish Safety and Reliability Association Summer Safety and Reliability Seminars, 4(1), pp. 21-27.
14) Lee, H. H. Y. & Scott, D. (2009). Overview of maintenance strategy, acceptable maintenance standard and resources from a building maintenance operation perspective. Journal of Building Appraisal, 4(4), pp. 269-278. doi: 10.1057/jba.2008.46.
15) Legát, V., Mošna, F., Aleš, Z. & Jurča, V. (2017). Preventive maintenance models – higher operational reliability. Eksploatacja i Niezawodnosc – Maintenance and Reliability, 19(1), pp. 134-141.
16) Legutko, S. (2009). Development trends in machines operation maintenance. Eksploatacja I Niezawodność – Maintenance and Reliability, 2(2), pp. 9.
17) Mikler, J. (2011). Life Cycle Costing Used for Justifying Transition to Predictive Maintenance Strategies. Journal of Machine Engineering, 11(4), pp. 49-58.
18) Mostafa, S., Dumrak, J. & Soltan, H. (2015). Lean Maintenance Roadmap. Procedia Manufacturing, Elsevier B.V., 2 (February), pp. 434-444. doi: 10.1016/j.promfg.2015.07.076.

19) Murthy, D. N. P., Atrens, A. & Eccleston, J. A. (2002). Strategic maintenance management. Journal of Quality in Maintenance Engineering, 8(4), pp. 287-305. doi: 10.1108/13552510210448504.
20) Ni, X. et al. (2016). Nonlinear degradation modeling and maintenance policy for a two-stage degradation system based on cumulative damage model. Eksploatacja i Niezawodnosc Maintenance and Reliability, 18(2), pp. 171-180. doi: 10.17531/ein.2016.2.3.
21) Okoh, C., Roy, R. & Mehnen, J. (2017). Predictive Maintenance Modelling for Through-Life Engineering Services. Procedia CIRP. The Author(s), 59(TESConf 2016), pp. 196-201. doi: 10.1016/j.procir.2016.09.033.
22) Ollila, A. & Malmipuro, M. (1999). Maintenance has a role in quality. The TQM Magazine, 11(1), pp. 17-21.
23) Özcan, E. C., Ünlüsoy, S. & Eren, T. (2017). A combined goal programming – AHP approach supported with TOPSIS for maintenance strategy selection in hydroelectric power plants. Renewable and Sustainable Energy Reviews, Elsevier Ltd, 78(May 2016), pp. 1410-1423. doi: 10.1016/j.rser.2017.04.039.
24) Pająk, M. & Woropay, M. (2009). Maintenance Strategy by Controlled Consumption of Operational Potential. Journal of KONES Powertrain and Transport, 16(4), pp. 365-374.
25) Rani, N., Baharum, M., Akbar, A. & Nawawi, A. (2015). Perception of Maintenance Management Strategy on Healthcare Facilities. Procedia – Social and Behavioral Sciences, V., 170, pp. 272-281. doi: 10.1016/j.sbspro.2015.01.037.
26) Sambrekar, A.A., Vishnu, C.R. & Sridharan, R. (2018). Maintenance strategies for realizing Industry 4.0: An overview. Emerging Trends in Engineering, Science and Technology for Society, Energy and Environment - Vanchipura & Jiji, pp. 341-348.
27) Shafiee, M. & Sørensen, J. D. (2017). Maintenance optimization and inspection planning of wind energy assets: Models, methods and strategies. Reliability Engineering and System Safety, pp. 1-19. doi: 10.1016/j.ress.2017.10.025.
28) Shafiee, M. (2015). Maintenance strategy selection problem: An MCDM overview. Journal of Quality in Maintenance Engineering, 21(4), pp. 378-402. doi: 10.1108/JQME-09-2013- 0063.
29) Sharma, R. K., Kumar, D. & Kumar, P. (2005). FLM to select suitable maintenance strategy in process industries using MISO model. Journal of Quality in Maintenance Engineering, 11(4), pp. 359–374. doi: 10.1108/13552510510626981.
30) Shin, J. H. and Jun, H. B. (2015). On condition based maintenance policy. Journal of Computational Design and Engineering, 2(2), pp. 119-127. doi: 10.1016/j.jcde.2014.12.006.
31) Srivastava, P., Khanduja, D. & Agrawal, V. P. (2017). A framework of fuzzy integrated MADM and GMA for maintenance strategy selection based on agile enabler attributes. Mathematics-in-Industry Case Studies, 8(1). doi: 10.1186/s40929-017-0014-y.
32) Tan, Z. et al. (2011). An evaluation of maintenance strategy using risk based inspection. Safety Science, 49(6), pp. 852-860. doi: 10.1016/j.ssci.2011.01.015.
33) Teixeira, F. & Junior, J. L. (2016). Methodology for assessing the probabilistic condition of an asset based in concepts of structural reliability "PCBM – Probabilistic Condition Based Maintenance". Procedia Structural Integrity, 1, pp. 181-188. doi: 10.1016/j.prostr.2016.02.025.
34) Tu, J. et al. (2015). Maintenance strategy decision for avionics system based on cognitive uncertainty information processing. Eksploatacja i Niezawodnosc – Maintenance and Reliability, 17(2), pp. 297–305.
35) Velmurugan, R. S. & Dhingra, T. (2015). Maintenance strategy selection and its impact in maintenance function: A conceptual framework. International Journal of Operations and Production Management, 35(12), pp. 1622-1661. doi: 10.1108/IJOPM-01-2014-0028.
36) Vilarinho, S., Lopes, I. & Oliveira, J. A. (2017). Preventive Maintenance Decisions through Maintenance Optimization Models: A Case Study. Procedia Manufacturing, 11(June), pp. 1170-1177. doi: 10.1016/j.promfg.2017.07.241.
37) Vishnu, C. R. & Regikumar, V. (2016). Reliability Based Maintenance Strategy Selection in Process Plants: A Case Study. Procedia Technology, pp. 1080-1087. doi: 10.1016/j.protcy.2016.08.211.

38) Wang, L., Chu, J. & Wu, J. (2007). Selection of optimum maintenance strategies based on a fuzzy analytic hierarchy process. International Journal of Production Economics, 107(1), pp. 151-163. doi: 10.1016/j.ijpe.2006.08.005.
39) Zeng, S. W. (1997). Discussion on maintenance strategy, policy and corresponding maintenance systems in manufacturing. Reliability Engineering and System Safety, 55(2), pp. 151-162. doi: 10.1016/S0951-8320(96)00004-X.
40) Zhang, C. et al. (2019). Opportunistic maintenance strategy for wind turbines considering weather conditions and spare parts inventory management. Renewable Energy, 133,pp. 703-711. doi: 10.1016/j.renene.2018.10.076.