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# APPLYING MACHINE LEARNING TO PERFORMANCE MANAGEMENT: OBSTACLES AND POTENTIAL

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## **ABSTRACT**

*Technology and big data have changed organizational management in many ways. Machine learning can improve performance management. This article examines how machine learning affects performance management accuracy, efficiency, and decision-making.*

*This paper reviews the literature on traditional performance management methods and their drawbacks. It then explains how machine learning algorithms can examine performance data, anticipate outcomes, and reveal patterns that may not be obvious. This paper also proposes a conceptual foundation for machine learning in performance management systems. This approach emphasizes data collection, pre-processing, algorithm selection, model training, and outcome interpretation.*

*This connection can deliver immediate, personalized feedback, identify high-performing and at-risk individuals, and provide data-driven insights for informed decision-making. To utilize machine learning in performance management ethically, data privacy and algorithm bias are addressed. This research shows that machine learning and performance management can revolutionize employee performance assessment and improvement.*

**Keywords:** *Machine learning, performance management, data-driven insights, employee performance, algorithm bias, organizational success.*

## **1. INTRODUCTION**

The pursuit of optimal performance and efficiency continues to be a primary focus for companies operating in all sectors, despite the fact that the current landscape is characterized by ever-changing organizational contexts. Traditional methods of performance management (Lebas, 1995; Vu et al., 2022) are going through a period of significant change as a direct result of recent developments in technology. One of these revolutionary forces is the incorporation of machine learning techniques into the arena of performance management, which ushers in a new era of data-driven insights and decision-making.

The term "performance management" refers to a core component of organizational management that incorporates a variety of actions with the objective of maximizing individual and collective contributions to the accomplishment of strategic objectives (P. Kumar, 2022). Traditionally,

performance management has been based on the use of formal frameworks that involve goal formulation, performance measurement, feedback, and performance review. Even though these old methodologies have given a basis for measuring the contributions of employees, they frequently fall short when it comes to reflecting the complexity and richness of the modern work environment (Alzubi et al., 2018) social. These types of systems have a number of drawbacks, including the possibility of subjectivity in evaluations, the presence of delayed feedback loops, and an inability to make use of the massive amounts of data that are available in the digitally connected world of today.

Machine learning, an interdisciplinary topic of artificial intelligence, lets computers learn and evolve without programming (Mahmoud et al., 2019). Machine learning algorithms can analyse big datasets, find patterns, and make predictions based on historical and real-time data (Hartford et al., 2016). This data-driven solution might revolutionize performance management by assessing and boosting staff performance. This expertise might revolutionize performance management. Performance management using machine learning shifts from static models to adaptive, dynamic, and tailored approaches. Machine learning lets firms get insights from a number of data sources, including employee interactions, project outcomes, consumer feedback, and operational measures. These insights enable a more complete perspective of individual and team performance, making correct and timely choices simpler.

This study paper's overarching objective is to investigate the myriad of ramifications that result from applying machine learning strategies to performance management procedures. This article aims to shed light on the potential benefits, obstacles, and considerations associated with a new paradigm by conducting an in-depth investigation of the subject at hand. An organization can obtain a full grasp of how the synergy between performance management and machine learning can help to the achievement of superior organizational results if the organization conducts critical analysis of the integration of machine learning within performance management.

In order to accomplish this goal, the subsequent sections of this paper will elaborate on key aspects. These aspects will include the fundamentals of machine learning, the development of performance management paradigms, the conceptual framework for integrating machine learning into performance management systems, case studies from the real world, ethical considerations, and the future trajectory of this ever-changing landscape. In the end, the purpose of this research is to

provide businesses with the knowledge they need to be able to make educated decisions regarding the use of machine learning in optimizing performance management processes and cultivating a culture of continuous improvement.

Harnessing the potential of machine learning in performance management is a strategic priority in light of the ongoing transformation that technology is causing to the corporate landscape. The purpose of this paper is to make a contribution to the ongoing conversation that is taking place about this transformative integration and to provide useful insights that will enable enterprises to successfully manage the complexity of this dynamic confluence.

## **2. LITERATURE REVIEW**

### **2.1. Machine Learning**

This academic literature study traces machine learning's development from its beginnings to the present (Garg et al., 2022). It chronologically covers milestones, technical advances, and paradigm shifts. The overview shows how machine learning has transformed several fields and industries from its mathematical logic roots to the present. Computational logic and learning machines were pioneered by Alan Turing and Frank Rosenblatt in the mid-20th century (Copeland & Proudfoot, 1999). Neural network-based learning began with perceptrons and Rosenblatt (Ayodele, 2010). Expert systems and symbolic AI originated in the 1960s with the 1956 Dartmouth Workshop, which founded machine learning (Alzubi et al., 2018).

Statistical approaches like decision trees, linear regression, and clustering enabled supervised and unsupervised learning. The shift from rule-based expert systems to data-driven learning occurred in the 1980s and 1990s, with advancements in neural networks, reinforcement learning, and evolutionary algorithms (Ayodele, 2010).

The machine learning Renaissance saw a resurgence in interest in support vector machines, boosting algorithms, and ensemble methods. The Deep Learning (LeCun et al., 2015) Revolution revived neural networks in the mid-2010s, fuelled by improved hardware, big data, and breakthroughs in convolutional and recurrent networks. Machine learning's integration into diverse domains, such as healthcare, finance (Athey, 2018). The impact of machine learning on

economics. Future directions and challenges include addressing ethical concerns and mitigating biases inherent in machine learning algorithms.

The history of machine learning (Jordan & Mitchell, 2015) is a testament to the relentless pursuit of teaching machines to learn and adapt. This study discusses machine learning's transformation from its theoretical roots to its widespread use and lays the way for future discoveries that will change our technology (El Naqa & Murphy, 2015).

## **2.2. Performance management**

This academic literature study explores performance management's development, models, and current viewpoints. Performance management history, classical models, and modern techniques are covered (Kumar, 2019). The review emphasizes performance management's significance in organizational success across industries and its changing function. Performance management began in the early 20th century and has progressed tremendously. Traditional assessment methods emphasized individual and organizational efficiency. Balanced scorecards, 360-degree feedback, and technological integration are modern methods. Performance management difficulties include prejudice and subjectivity, continuous performance monitoring, digital transformation, employee engagement, diversity and inclusion, and future directions and challenges (Kumar & Nirmala, 2015).

Modern performance management is data-driven and employee-focused. Future research may explore how performance management adapts to agile work environments and remote work arrangements. Overall, this review provides insights into the historical trajectory, models, challenges, and emerging trends shaping performance management in modern organizations.

## **3. RESEARCH GAPS**

Despite theoretical discussions on machine learning in performance management, empirical evidence on its efficacy across industries and organizational sizes is few. The lack of experiments testing machine learning algorithms in real-world contexts shows a gap in academic expertise. The use of machine learning to measure a wide range of performance metrics, including qualitative measures and team and individual performance, remains understudied (El Naqa & Murphy, 2015).

This research gap. Algorithm transparency and explain ability research to solve these issues is few. Machine learning in performance management requires organizational changes and employee agreement. However, research gaps remain in understanding successful change management methods and organizational preparation and employee acceptance. The long-term effects of using machine learning in performance management need more research. This integration's long-term consequences on business culture, employee development, and performance remain unknown. Thus, the following research questions are formed from the aforesaid research gaps:

1. What are the ways in which machine learning algorithms enhance the accuracy of performance evaluation and the validity of predictions, and how do these methods differ across various sectors and organizational contexts?
2. What are the main obstacles and opportunities associated with incorporating machine learning into quantitative and qualitative performance assessments, and what is the overall impact of this integration on performance?
3. In what ways can various machine learning algorithms align with performance management goals, such as supervised, unsupervised, and reinforcement learning? Additionally, how can the optimal algorithm be selected for a particular scenario?
4. How should training programs be designed and delivered to provide managers and staff the knowledge and abilities they need to use machine learning-enabled performance management systems efficiently?

By addressing these research questions within an academic framework, we may gain a deeper understanding of the intricacy, implications, and potential advantages of using machine learning to performance management across a range of organizational contexts. This knowledge will be useful in many different contexts.

#### **4. RESEARCH METHODOLOGY**

For this study, review of scholarly publications within a certain field. The purpose of this evaluation is to identify the research gaps within the topic of "Applying Machine Learning to Performance Management." Identified research gaps include interdisciplinary collaboration,

ethical considerations, practical implementation, and industry-specific insights. Further research is required to study the practical problems and best practices that organizations experience when using machine learning-driven performance management systems. The following steps were undertaken to conduct this analysis:

**4.1. Data Collection:** A comprehensive search was conducted in reputable academic databases (e.g., IEEE Xplore, Scopus, Web of Science etc.) using relevant keywords such as "machine learning," "performance management", "employee assessment," etc. Only peer-reviewed journal articles, conference papers, and scholarly publications were considered. This paper presents a road map for future research in this rapidly developing subject by highlighting research needs relating to interdisciplinary collaboration, ethical considerations, practical application, and industry-specific insights.

## 5. FINDINGS AND DISCUSSION

Discussing the findings section of a research paper involves presenting the results of study in a clear, organized, and concise manner. The following research paper conclusions are based on the study questions:

**RQ1:** What are the ways in which machine learning algorithms enhance the accuracy of performance evaluation and the validity of predictions, and how do these methods differ across various sectors and organizational contexts?

The first subject, how machine learning algorithms increase performance evaluation accuracy and prediction validity, is complex. This question is modified by algorithms, data availability, industry features, and organizational settings (Girshick et al., 2014). In this part, we will examine how machine learning might enhance performance assessments and how these benefits may vary between organizational contexts and business sectors.

Machine learning algorithms may detect intricate patterns and connections in massive datasets that conventional methods cannot. Machine learning algorithms can uncover subtle relationships between many features and performance results by analyzing historical performance data (Freitag, 1998). Machine learning may include employee interactions, feedback, and even market

movements beyond typical performance assessments. This holistic perspective makes it possible to conduct a more in-depth evaluation of an employee's contributions. Learning machines have the ability to personalize performance reviews for each employee by taking into account parameters such as their job description, level of expertise, years of experience, and preferences (Mahesh, 2020). Traditional evaluations have a more cookie-cutter approach, but this personalisation eliminates the need for that. Algorithms that learn from machine data can process data in real time, which enables continuous assessment and modification of performance indicators. Because of this agility, fast identification of performance patterns and the ability to intervene when problems develop are both made possible (Du & Swami, 2013). Using past data and the most recent patterns, machine learning algorithms are able to make projections about future performance. Because of this skill, businesses are able to recognize high-performing personnel, identify possible areas for improvement, and even forecast the likelihood of employee departure.

Performance measures for machine learning algorithms vary by industry, with tech companies focusing on innovation and project completion, while sales-driven industries focus on revenue measures. Industry data availability varies, with abundant data sources enhancing accuracy more than limited data. The nature of labor and tasks varies, with advantages varying for quantitative functions like sales and subjective ones like artistic fields. The success of integrating machine learning depends on an organization's ability to accept data-driven techniques. Societies that value data and innovation may experience gradual progress, while industries subject to regulatory restraints, like healthcare (Holzinger, 2018), may face difficulties. The size and composition of an organization also impact the feasibility of implementing machine learning. Larger firms with extensive data may experience significant gains, while openness among employees and managers regarding machine learning evaluations may be more favorable. Businesses with a long track record of embracing new technologies may take these improvements more readily.

**RQ2:** What are the main obstacles and opportunities associated with incorporating machine learning into quantitative and qualitative performance assessments, and what is the overall impact of this integration on performance?

This literature review explores the benefits and cons of integrating machine learning into quantitative and qualitative performance measurements. It analyzes existing research to determine the challenges businesses may face during integration, its possible benefits, and its overall impact

on holistic performance assessment (Saranya et al., 2020). The integration of quantitative and qualitative data presents challenges such as data heterogeneity, subjectivity in qualitative data, feature selection, algorithm selection, and bias and interpretability (Mahesh, 2020).

Opportunities for improvement include comprehensive performance assessment, predictive insights, individualization, and pattern recognition. Integrating diverse data types enhances the accuracy of performance assessments, capturing a more complete picture of an individual's contributions (P. Kumar, 2022). This holistic impact on performance includes accuracy, motivation and engagement, feedback and development, and team dynamics.

The literature review investigates the alignment between different machine learning algorithms (Ayodele, 2010), including supervised, unsupervised, and reinforcement learning, with performance management objectives. By examining real-world applications and organizational contexts, the review contributes to a deeper understanding of the interplay between algorithm selections and achieving optimal performance outcomes (Girshick et al., 2014).

**RQ3:** In what ways can various machine learning algorithms align with performance management goals, such as supervised, unsupervised, and reinforcement learning? Additionally, how can the optimal algorithm be selected for a particular scenario?

Organizations are increasingly focusing on data-driven insights for optimizing performance management, making the selection of appropriate machine learning algorithms crucial (Ray, 2019). Supervised learning, unsupervised learning, reinforcement learning, and reinforcement learning are all algorithms that can be used for various performance management objectives (Mahesh, 2020). Supervised learning is suitable for predicting employee turnover, performance rankings, and skill gaps identification, while unsupervised learning is suitable for data exploration, clustering, and identifying hidden patterns within unstructured data. Reinforcement learning is ideal for optimizing decision-making processes, such as resource allocation, task scheduling, and policy optimization (Strehl et al., 2010; Williams et al., 2017; Nagabandi et al., 2018).

Choosing the best algorithm depends on several factors, including the nature of the data (structured, unstructured, labeled, unlabeled), performance goals (prediction, clustering, optimization), algorithm complexity, data quality and quantity, interpretability, scalability, and organizational context. Supervised learning requires labeled data, while unsupervised learning can



handle unlabeled data. Algorithm complexity is influenced by the computational resources available in the organization, while data quality and quantity are crucial for effective training (Kelleher et al., 2020). Interpretability is also a critical factor, and scalability is essential for larger organizations with extensive datasets. Overall, the choice of the best algorithm depends on the organization's culture, technical infrastructure, and expertise (Ayodele, 2010).

**RQ4:** How should training programs be designed and delivered to provide managers and staff the knowledge and abilities they need to use machine learning-enabled performance management systems efficiently?

This study outlines best practices for planning and delivering training programs aimed at equipping employees and managers with the skills and understanding required to effectively operate machine learning-enabled performance management systems (Belavagi & Muniyal, 2016). Drawing on a comprehensive analysis of literature and practical insights, this research provides a framework for designing training initiatives that promote user proficiency, enhance engagement, and optimize the integration of machine learning into performance management processes.

This study focuses on the essential components of effective training programs for organizations to effectively utilize machine learning-enabled performance management systems (P. Kumar, 2022). It outlines the need for a needs assessment, tailoring training content to user roles, and designing effective training that introduces basic machine learning concepts, hands-on exercises, real-life scenarios, and tools.

Interactive learning, gamification, and role-specific content are essential components for maintaining engagement and facilitating knowledge retention (Hartford et al., 2016). Addressing concerns related to data privacy, algorithmic bias, and ethical implications is crucial for responsible system usage (Ray, 2019). Change management is necessary to prepare participants for the cultural and operational shifts that accompany the integration of machine learning systems.

Continuous learning is essential, with refresher sessions, feedback loops, and evaluation and assessment methods (Saranya et al., 2020). Assessment metrics are essential for assessing participants' understanding, skill development, and knowledge application. Feedback surveys are used to gather insights for refining future training programs. Overall, effective training programs should address existing skills gaps, cater to different user roles, and provide a comprehensive

learning experience for users to navigate and leverage machine learning-enabled performance management systems confidently (Kelleher et al., 2020).

## **6. CONCLUSION**

In summary Machine learning algorithms improve performance evaluation accuracy and predictive validity by utilizing pattern recognition, data-driven insights, individualization, real-time analysis, and predictive analytics. However, these enhancements vary across industries and organizational settings due to factors like data availability, employee roles, culture, regulatory constraints, organizational size, and change management readiness. Successful implementation requires tailoring machine learning approaches to align with industry dynamics and contexts. Integrating machine learning across quantitative and qualitative performance assessments requires data handling, algorithm selection, and bias prevention. The integration's benefits include comprehensive evaluation, predictive insights, individualization, and pattern recognition. Matching machine learning algorithms with performance management objectives requires a careful understanding of their capabilities and alignment with specific goals. Supervised, unsupervised, and reinforcement learning offer unique advantages depending on the objectives. A thoughtful approach to algorithm selection ensures that machine learning enhances performance management efforts. Effective training programs are crucial for successful integration of machine learning-enabled performance management systems. Adhering to best practices, including needs assessment, user engagement, ethical considerations, and continuous learning, ensures employees and managers are equipped with the skills and understanding needed to navigate these systems effectively.

## **7. IMPLICATION**

This study has significant academic implications across various disciplines, contributing to the advancement of knowledge and practice in various fields. It challenges traditional evaluation methods by integrating machine learning into performance management, leading to the development of novel assessment frameworks that incorporate data-driven insights. The integration of machine learning in performance management can lead to tailored development

paths, optimizing employee growth and potential. Analyzing the correlation between machine learning-enabled performance management and employee engagement can reveal how data-driven feedback impacts workforce motivation and commitment. Researchers need to address concerns related to algorithmic bias, transparency, and fairness, contributing to the development of ethical machine learning practices within the context of performance management.

Employee perception and acceptance of machine learning-driven performance management systems can contribute to understanding the psychological impact of such systems on individuals. Data-driven feedback on employee motivation can provide insights into the effectiveness of tailored performance incentives. Analyzing the effects of data-driven performance management on overall organizational outcomes can provide insights into the link between employee effectiveness and business success. Addressing ethical implications of machine learning applications in performance management contributes to discussions on reducing bias and ensuring fairness.

Studies on employee acceptance and interaction with machine learning-enabled systems offer insights into user adoption and factors influencing it. Developing effective training programs to educate employees and managers on operating machine learning-enabled performance management systems contributes to evolving workplace technologies. Examining the legal and regulatory aspects of using machine learning in performance management contributes to discussions on creating responsible and compliant frameworks for technology adoption.

## **8. FUTURE RESEARCH**

Future research on applying machine learning to performance management can address new problems, improve existing techniques, and contribute to a deeper understanding of the consequences of incorporating machine learning into performance management procedures. Key areas of investigation include ensuring ethical use of machine learning algorithms, collaborating effectively between humans and algorithms, studying the long-term impact of machine learning-enabled performance management on employee motivation and engagement, integrating machine learning-enhanced performance management with other organizational functions, developing effective change management strategies, preparing employees, managers, and stakeholders for

adoption, exploring adaptive learning systems, developing algorithms that optimize performance management based on multiple objectives, and fostering collaboration between HR professionals, data scientists, ethicists, psychologists, and organizational experts. Additionally, exploring the potential of machine learning to predict individual skill development trajectories and provide personalized learning recommendations. User-centered design principles should be considered, and cultural and regional factors should be considered when implementing machine learning in performance management. Hybrid approaches that combine machine learning insights with human expertise in decision-making should be explored, balancing data-driven analysis and qualitative assessments. Real-time feedback systems can also be explored to foster agility and adaptability in performance improvement efforts. Future research in these areas will contribute to a comprehensive understanding of the implications, challenges, and opportunities associated with applying machine learning to performance management, guiding organizations toward effective and responsible adoption of these technologies.

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