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Regulatory Implications of AI-enabled Hazard Detection: Aligning YOLO-Based Safety Systems with OSHA and New York State Frameworks

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Abstract

This research examines the regulatory implications of integrating AI-enabled hazard-detection systems, specifically YOLO-based computer-vision technologies, into occupational safety frameworks in New York State. The study evaluates the alignment of real-time detection systems with existing OSHA standards and state-level regulatory requirements. Findings indicate that while AI technologies significantly enhance hazard detection performance and compliance monitoring, current regulatory frameworks remain largely structured around manual inspection models. The paper introduces a governance-based approach, grounded in the AI-Augmented Safety Governance Model (AASGM), to support the integration of AI systems within existing regulatory environments. The findings highlight the need for adaptive regulatory strategies that incorporate real-time monitoring, human oversight, and accountability mechanisms. The study contributes to the advancement of Safety 4.0 by bridging technological innovation with regulatory policy and governance structures.

Keywords: AI governance; occupational safety regulation; OSHA; New York State; hazard detection; Safety 4.0; compliance; AASGM

1. Introduction

Occupational safety regulation in the United States is primarily governed by frameworks established by the Occupational Safety and Health Administration (OSHA), which emphasize compliance through inspections, reporting, and enforcement actions. While these frameworks have been effective in improving baseline safety conditions, they remain largely dependent on periodic inspections and retrospective incident analysis (OSHA, 2024).

The emergence of artificial intelligence (AI)–enabled hazard detection systems presents a fundamental shift in how safety risks can be identified and managed. Technologies such as YOLO-based computer vision systems enable continuous, real-time monitoring of workplace environments, allowing hazards to be detected and addressed before incidents occur.

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Despite these advancements, current regulatory frameworks have not fully adapted to incorporate AI-enabled safety systems. This creates a gap between technological capability and regulatory practice, particularly in complex regulatory environments such as New York State.

This study examines how AI-enabled hazard-detection systems can align with existing OSHA and New York State regulatory frameworks and proposes a governance-based approach to support their integration.

The research contributes to a broader research program advancing the AI-Augmented Safety Governance Model (AASGM) by examining the alignment of AI-enabled hazard detection systems with regulatory frameworks and policy requirements. Building on prior analyses of technical performance, human factors, and socio-technical integration, this research explores how AI-driven safety systems can support compliance with existing occupational safety standards and inform the development of adaptive regulatory approaches. By situating AI-enabled safety technologies within a policy and governance context, this study offers a structured perspective on how organizations can integrate advanced detection capabilities into compliant, accountable safety management practices.

Furthermore, the study expands upon the established formal governance framework from prior analysis by investigating the alignment of AI-enabled safety systems with regulatory requirements, policy development, and institutional oversight mechanisms within this coordinated research series.

This manuscript is part of the Shawe Series, a coordinated research program examining artificial intelligence–enabled hazard detection, socio-technical safety integration, and governance frameworks in regulated workplace environments. The series advances the AI-Augmented Safety Governance Model (AASGM) as a unifying framework linking real-time detection technologies, human oversight, regulatory compliance, and organizational decision-making.

2. Regulatory Landscape

2.1 OSHA Framework

OSHA regulations are structured around compliance-based inspection models, which rely on periodic site visits, hazard reporting, and enforcement mechanisms (OSHA, 2024). These approaches are effective for identifying known hazards but are limited in their ability to detect dynamic or transient risks.

2.2 New York State Context

New York State introduces additional complexity through state-specific safety regulations, public sector requirements (e.g., PESH), and overlapping compliance obligations. These layered regulatory requirements reflect the complexity of integrating emerging technologies within state-level occupational safety frameworks, where federal OSHA standards intersect with state-

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specific enforcement mechanisms such as New York's Public Employee Safety and Health (PESH) program.

2.3 Limitations of Current Frameworks

Traditional regulatory models are primarily reactive, relying on human observation and periodic inspection, which limits their ability to capture dynamic, time-sensitive hazards. These constraints reduce temporal coverage and delay intervention, particularly in complex and rapidly changing work environments.

3. AI-Enabled Safety Systems and Compliance

AI-enabled hazard detection systems improve compliance by providing continuous monitoring, enabling real-time hazard identification, and enhancing documentation and reporting processes. These capabilities support more consistent enforcement of safety standards and facilitate proactive safety management practices.

However, these systems also introduce regulatory challenges, including concerns about data privacy, accountability for automated or semi-automated decision-making processes, and the integration of AI technologies into existing compliance frameworks.

The analysis indicates that AI-enabled hazard detection systems improve regulatory responsiveness by enhancing real-time hazard visibility, documentation consistency, and proactive compliance monitoring. However, the findings also suggest that existing regulatory frameworks remain primarily structured around retrospective inspection models, creating governance gaps related to AI accountability, data management, and institutional oversight. These findings support the need for adaptive governance structures capable of integrating AI-enabled monitoring systems within existing occupational safety regulations.

3.1 Methodological Approach

This study employs a qualitative policy and governance analysis approach grounded in socio-technical systems theory and the AI-Augmented Safety Governance Model (AASGM). The analysis synthesizes prior empirical findings from earlier studies within the Shawe Series, including technical performance evaluation, human–AI interaction analysis, and convergent socio-technical integration, to examine how AI-enabled hazard-detection systems align with existing occupational safety regulatory frameworks.

The study further incorporates a comparative analysis of OSHA standards, New York State occupational safety requirements, and governance-oriented literature on artificial intelligence, organizational oversight, and adaptive regulatory systems. This integrative approach supports the development of a structured governance framework for aligning AI-enabled safety technologies with regulatory compliance and institutional accountability mechanisms.

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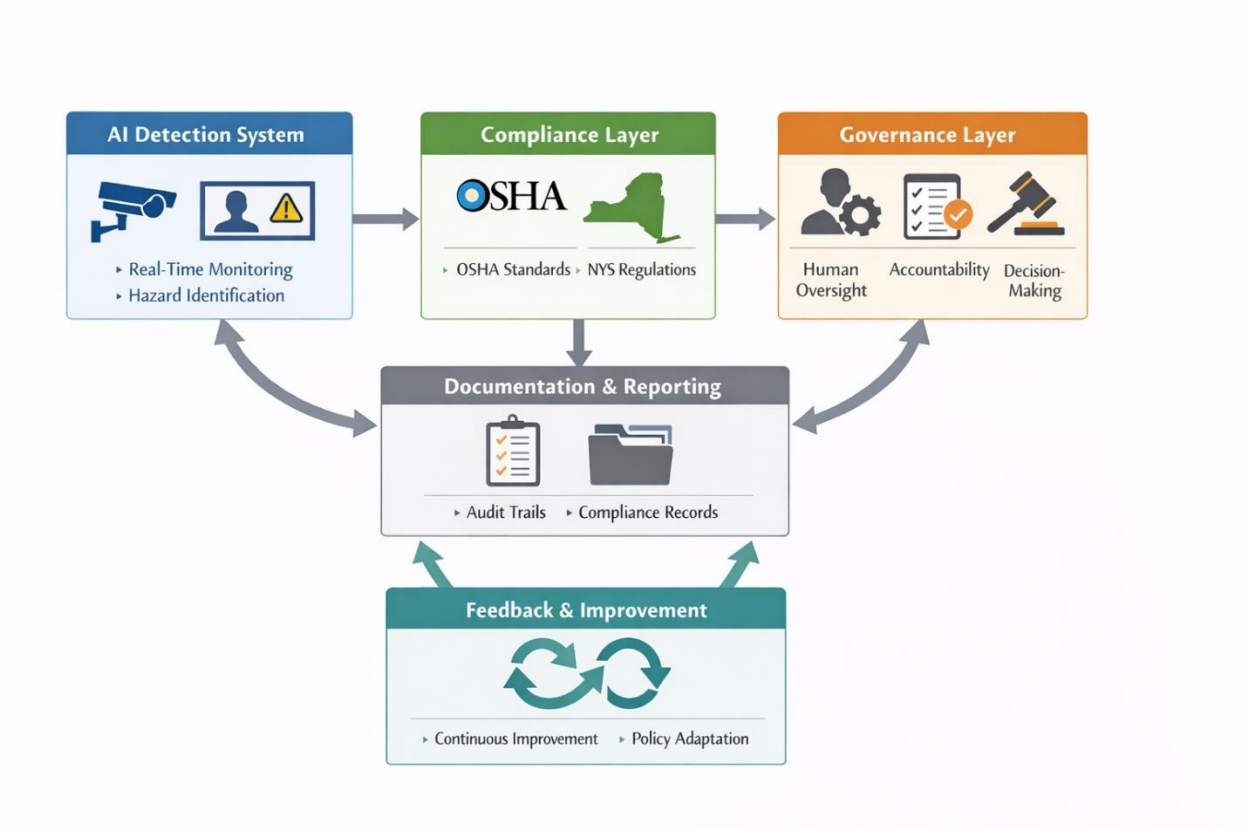
4. Regulatory Alignment Framework

To illustrate how AI-enabled hazard detection systems can be effectively integrated into existing regulatory structures while maintaining compliance, accountability, and human oversight at both the regulatory and organizational levels, Figure 1 presents a regulatory alignment framework based on the AI-Augmented Safety Governance Model (AASGM). The framework demonstrates how real-time detection technologies interface with OSHA requirements, New York State regulations, and organizational governance mechanisms.

Figure 1

Regulatory alignment framework for AI-enabled hazard detection systems



Note. Author created. The framework illustrates how AI-based detection systems integrate with OSHA and New York State regulatory requirements through governance mechanisms, documentation processes, and continuous feedback loops. Human oversight remains central to ensuring accountability and compliance.

As illustrated in Figure 1, integrating AI-enabled hazard detection systems into regulatory frameworks requires a governance-centered approach that aligns technological capabilities with

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compliance requirements and accountability structures. The framework demonstrates that effective regulatory alignment depends not only on the performance of AI systems but also on the incorporation of human oversight, transparent reporting mechanisms, and adaptive policy structures. This integrated approach supports the transition from reactive compliance models to proactive, data-driven safety governance systems.

5. Discussion

The findings of this study highlight a critical gap between current regulatory frameworks and emerging AI-enabled safety technologies. While AI systems enhance hazard detection and compliance monitoring, their integration requires modifications to existing regulatory approaches. These findings suggest that regulatory adaptation must evolve from static compliance models toward dynamic, data-informed governance structures capable of integrating real-time AI-generated safety insights.

The AASGM provides a structured framework for addressing these challenges by aligning AI technologies with governance and compliance mechanisms. This approach supports the evolution of regulatory systems toward proactive safety management.

Beyond alignment with existing regulatory frameworks, these findings have direct implications for safety governance and policy implementation. The integration of AI-enabled hazard-detection systems within OSHA and New York State regulatory contexts highlights the need for governance structures that translate real-time safety data into compliant, accountable organizational practices. AI-driven detection capabilities offer the potential to enhance regulatory adherence by improving hazard visibility, documentation, and response consistency. Within the AI-Augmented Safety Governance Model (AASGM), these results demonstrate how technological capability can be operationalized within structured governance systems to support regulatory compliance, institutional oversight, and the development of adaptive policy frameworks in evolving occupational safety environments.

In this context, the AASGM demonstrates practical value as a governance-oriented framework that integrates AI-enabled hazard detection with institutional oversight, compliance management, and adaptive regulatory decision-making processes.

6. Limitations

This study is subject to several limitations. First, the analysis is grounded in the regulatory context of OSHA and New York State frameworks, which may limit the generalizability of the findings to other jurisdictions with differing legal, institutional, and enforcement structures. Second, while the study examines alignment between AI-enabled hazard detection systems and existing regulatory requirements, variations in organizational implementation, compliance practices, and regulatory interpretation may influence real-world applicability. Third, the regulatory landscape for artificial intelligence in occupational safety is evolving, and current

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policies may not fully reflect future technological capabilities or governance needs. Future research should examine cross-jurisdictional comparisons, longitudinal policy adaptation, and the effectiveness of governance frameworks in supporting regulatory compliance across diverse institutional environments.

7. Conclusion

This study demonstrates that AI-enabled hazard detection systems can significantly enhance compliance and safety performance when aligned with regulatory frameworks through governance-based approaches. The integration of AI within OSHA and New York State safety systems requires adaptive regulatory strategies that incorporate real-time monitoring, human oversight, and governance-based accountability mechanisms. As AI-enabled safety technologies continue to evolve, regulatory institutions and organizations must develop flexible governance structures capable of balancing technological innovation, workforce protection, ethical accountability, and regulatory compliance within increasingly data-driven occupational safety environments.

Conflict of Interest Statement

The author declares no conflicts of interest related to the research, analysis, or preparation of this manuscript. No external funding, sponsorship, or commercial support was received for this study. All interpretations and conclusions reflect the author's independent scholarly judgment and professional expertise.

Originality Statement

This manuscript represents original scholarly work and has not been published previously in any form. It is not under review by any other journal or publication outlet. The author independently developed all conceptual frameworks, analyses, and written content as part of the Shawe Series research program.

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