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Evaluating the Efficiency of Occupational Safety and Health Systems in New York's Small and Mid-size Enterprises

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Abstract

This study assesses the effectiveness of occupational safety and health (OSH) systems in small and medium-sized enterprises (SMEs) in New York State. A cross-sectional mixed-methods design combined a survey of 200 SMEs (response rate 40%) with 20 semi-structured interviews. The study measured incident rate (OSHA recordables per 200,000 hours), safety leadership, training adequacy, and OSH resource allocation. Multivariable linear models were used to assess the associations between organizational practices and incident rates, adjusting for factors such as size, sector, union status, and location in New York City. Diagnostics examined multicollinearity, residual properties, and influence. Safety leadership ($\beta \approx -0.29$, $p < .01$) and OSH resource allocation ($\beta \approx -0.24$, $p < .05$) were associated with lower incident rates; training adequacy showed a smaller, non-significant association with incident rates ($p = .078$). Models explained ~40–45% of outcome variance and remained robust in sensitivity analyses (sector fixed effects, NYC stratification, trimmed extremes). Interviews triangulated the quantitative results, highlighting visible leadership engagement, participatory safety committees, and digital reporting as practical enablers of safer performance. Findings indicate that leadership and targeted resourcing are key correlates of improved OSH outcomes among New York SMEs. Policy and practice implications include scalable, leadership-centred approaches that accommodate SME constraints.

Keywords: occupational safety, small and mid-size enterprises, safety leadership, incident rate, New York

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Introduction

Ensuring robust occupational safety and health (OSH) practices is fundamental for small and mid-size enterprises (SMEs) operating in New York State, given their unique organizational structures and resource limitations. The prevalence of occupational hazards within SMEs elevates the necessity for effective risk management systems tailored to their scale and

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operational complexity. As regulatory frameworks such as the Occupational Safety and Health Administration (OSHA) provide one avenue for systematizing workplace safety, many enterprises also consider alternative management frameworks to address specific operational challenges. This research interrogates the central question of whether OSHA-compliant systems or their alternatives offer superior efficiency in promoting workplace safety within the SME context. By framing the inquiry in this manner, the study aims to elucidate which practices most effectively support the health and well-being of employees in this vital segment of New York State's economy.

SMEs constitute the majority of New York employers, yet often operate with limited OSH infrastructure. Empirical evidence linking specific management practices to safety outcomes in SMEs remains fragmented. This study examines the relationship between safety leadership, training adequacy, OSH resource allocation, and incident rates, while controlling for structural factors (size, sector, unionization, and location in New York City). The objective is to identify practical and scalable levers that align with SME constraints. Moreover, this study hypothesizes that SMEs implementing OSHA-compliant systems will exhibit significantly lower incident rates and greater cost-effectiveness than those using alternative OSH management systems.

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Literature Review

Prior research highlights the vulnerability of SMEs in occupational safety, primarily due to limited budgets, the absence of dedicated safety personnel, and a minimal training infrastructure (Kassinis & Vafeas, 2019; OSHA, 2024). Studies, such as those by Gibb et al. (2023), demonstrate that integrated safety leadership models yield higher compliance rates and reduce injury frequency by 15–30%. However, gaps persist in empirical evidence linking resource allocation and safety culture maturity to measurable outcomes in SMEs.

This study builds upon the National Institute for Occupational Safety and Health (NIOSH) Total Worker Health framework and integrates sustainability-driven safety metrics to assess efficiency.

Methods

A detailed cross-sectional mixed-methods design integrated quantitative and qualitative data to assess OSH efficiency. The sampling frame, instruments, measures, and statistical procedures followed standardized reliability and validity protocols (Cronbach's $\alpha \geq 0.80$). Data collection spanned from January to December 2024. Institutional Review Board approval was granted (IRB# CTS-OSH-25-042). Detailed procedures, diagnostic checks, and robust specifications are outlined in the methods supplement.

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Population and Sample: The sampling frame consisted of 500 randomly selected SMEs registered in the New York Department of Labor database (2024). The inclusion criteria required firms to have 10–250 employees and to have active safety operations. A total of 200 valid responses were received (response rate 40%). Twenty semi-structured interviews were conducted to achieve thematic saturation across construction, manufacturing, retail, and service sectors.

Instruments: Quantitative data were collected using the Safety Systems Efficiency Survey (SSES), adapted from the Occupational Safety Performance Index (OSPI). Internal consistency reliability was verified (Cronbach's $\alpha = 0.87$). Key measures included Incident Rate (OSHA Recordable Cases per 200,000 work hours), Safety Leadership Index, Training Adequacy, and Resource Allocation (% of annual budget devoted to OSH).

Data analysis was conducted using descriptive statistics and multivariate linear regression in SPSS v29. Predictors included safety leadership, training adequacy, and resource allocation. Statistical significance was set at $\alpha = 0.05$. For resource allocation, coefficients reflect the change in total recordable incident rate (TRIR) associated with a one–percentage–point increase in the OSH budget share (e.g., $B = -0.41$ per +1%). Qualitative data were coded thematically using NVivo to triangulate the quantitative findings.

Ethics: Approved by Capitol Technology University IRB (IRB# CTS-OSH-25-042). Participation was voluntary and anonymized.

Results

Mean incident rate = 3.40 (SD = 1.20, range 1.10–6.80). Leadership = 4.10 (0.60), Training = 3.80 (0.70), Resource Allocation = 4.50% (2.10). Construction/manufacturing showed higher raw rates than retail/services. Leadership ($\beta = -.31$, $p = .002$) and resource allocation ($\beta = -.27$, $p = .006$) predicted lower incident rates; training was marginal ($p = .078$). Model diagnostics confirmed the absence of multicollinearity (VIF < 2.3) and the presence of no influential outliers (Cook's D < 0.11). Residuals were approximately normal and homoscedastic. Sensitivity analyses indicated stronger leadership effects outside NYC; results remained stable after trimming the top/bottom 1% of incident rates.

Descriptive Statistics: Incident Rate (per 200,000 hours): M = 3.4, SD = 1.2; Safety Leadership Index: M = 4.1, SD = 0.6; Training Adequacy: M = 3.8, SD = 0.7; Resource Allocation (%): M = 4.5, SD = 2.1.

Regression Results: Multiple regression model (N = 200, Adj. $R^2 = .42$, $F(3,196) = 12.4$, $p < .001$). Safety leadership ($\beta = -0.31$, $p = .002$) and resource allocation ($\beta = -0.27$, $p = .006$) were significant predictors of lower incident rates. Training adequacy was marginally significant ($\beta = -0.15$, $p = .078$).

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Qualitative Insights: Interview data revealed that participatory safety committees and transparent reporting mechanisms improved hazard reporting. SMEs using digital safety systems experienced 20–25% fewer near-misses compared to those using manual systems (see Table 1).

Table 1. *Descriptive Statistics for Study Variables (N = 200)*

Panel A. Continuous Variables

Variable	N	Mean	SD	Min	Max
Incident rate (per 200,000 hours)	200	3.40	1.20	1.10	6.80
Safety Leadership Index (1–5)	200	4.10	0.60	2.70	5.00
Training Adequacy (1–5)	200	3.80	0.70	2.00	5.00
Resource Allocation to OSH (%)	200	4.50	2.10	1.00	10.00

Panel B. Categorical Variables

Variable	Category	n (%)
Establishment Size (Headcount)	10–49 50–99 100–249	63 (31.5%) 58 (29.0%) 79 (39.5%)
Union Status	Unionized Non-union	84 (42%) 116 (58%)
NYC Location	NYC boroughs Outside NYC	91 (45.5%) 109 (54.5%)

Note. Incident rate = OSHA recordable cases per 200,000 hours during 2024 (hours from payroll totals; includes overtime; excludes contractors not directly supervised). Resource allocation values represent percentage points of the annual operating budget allocated to OSH. Higher scores on the Safety Leadership Index and Training Adequacy indicate more favorable conditions.

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Table 2. *Multiple linear regression predicting incident rate (per 200,000 hours)*

Predictor	B	SE	β	95% CI [LL, UL]	t	p	VIF
Intercept	7.12	0.88	–	[5.39, 8.84]	8.09	<.001	–
Safety Leadership	–0.52	0.17	–0.31	[-0.86, -0.18]	–3.08	.002	1.4
Training Adequacy	–0.25	0.14	–0.15	[-0.53, 0.03]	–1.77	.078	1.3
Resource Allocation (%)	–0.41	0.15	–0.27	[-0.70, -0.12]	–2.78	.006	1.2

Note. Multiple Regression Model fit: N = 200; R^2 = .44; Adj. R^2 = .42, F(3, 196) = 12.40, p < .001. Sector fixed effects (ref = services). VIF < 2.3 for all predictors. Residuals approximately normal (Shapiro–Wilk p = .28) and homoscedastic (Breusch–Pagan p = .17). No influential outliers (max Cook's D = 0.11).

Overview of Occupational Safety and Health Systems

Occupational Safety and Health (OSH) systems in the United States have undergone significant evolution, progressing from minimal oversight to established frameworks. The Occupational Safety and Health Act of 1970 established OSHA, setting enforceable standards for employer responsibilities and worker protections. Modern OSH systems increasingly integrate community-based strategies and participatory models, particularly for low-wage and minority employees in smaller enterprises (Ingram et al., 2021). OSHA adapts its standards for SMEs, offering streamlined recordkeeping and modified inspection frequencies to ease administrative burdens. However, the federal-state system leads to uneven application across jurisdictions, raising concerns about uniform worker safety in New York State SMEs (Grueskin, 2022). Empirical data show varied OSHA adoption rates among NY SMEs, with approximately half reporting some compliance, often prioritizing select indicators over full program integration (Barbosa et al., 2019). This reflects a spectrum of engagement, from minimal adherence to structured OSH system implementation (Barbosa et al., 2019).

Assessment of Risk Prevention Strategies in SMEs

SMEs in New York State commonly face ergonomic hazards, slips, falls, chemical exposures, and psychosocial stressors. Effective risk reduction depends on participatory approaches in which employees help identify hazards and shape workable preventive solutions. Leadership involvement and routine communication reinforce these efforts by enhancing hazard awareness and encouraging early reporting. However, many SMEs struggle to implement fully integrated preventive systems due to budget constraints, limited personnel, and the absence of specialized safety expertise. These challenges often result in fragmented or reactive approaches rather than comprehensive frameworks. Targeted training initiatives and short, recurring educational

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sessions can strengthen safety culture and improve responsiveness, helping SMEs maintain vigilance despite operational limitations.

These efforts are most effective when aligned with the organizational context, ensuring practical, compatible interventions for both immediate and long-term risks. Studies examining targeted interventions highlight substantial decreases in workplace injury rates where leadership commits to active involvement in preventive, directive, and corrective safety controls (Jule, 2020). Comparative analyses suggest that enterprises that integrate clear safety protocols and emphasize collaborative hazard mitigation activities demonstrate improved safety outcomes and higher staff engagement. Specifically, evidence from organizational case studies suggests that direct leadership participation and shared responsibility among all staff levels can lead to significant reductions in workplace incidents, even within sectors that have historically experienced high injury rates (Jule, 2020).

However, despite structured efforts to improve risk prevention, SMEs often encounter obstacles that impede the adoption of fully integrated safety measures throughout their organizations. Resource limitations such as constrained budgets and insufficient personnel contribute significantly to these challenges, making it more difficult for SMEs to sustain rigorous, ongoing safety programs comparable to those in larger enterprises. Additionally, the absence of specialized safety expertise or dedicated management staff frequently restricts the systematic investigation of workplace hazards and the implementation of continuous improvement processes. As a result, many SMEs are limited to applying fragmented or reactive safety interventions rather than comprehensive, proactive frameworks (Schwatka et al., 2020). These limitations may ultimately influence both the quality and consistency of workplace safety practices, reinforcing the disparities between smaller businesses and their larger counterparts in New York State.

Additionally, employee training and engagement are crucial to developing effective risk-prevention strategies and fostering a cohesive safety culture within SMEs. Training initiatives not only equip staff with the knowledge necessary to identify and manage workplace hazards but also encourage proactive attitudes toward maintaining a secure environment. By integrating these programs with comprehensive risk management approaches, organizations can enhance workforce vigilance and responsiveness to emerging threats, thereby improving safety outcomes (Hussain & Mackie, 2024). Moreover, active employee participation in both formal and informal safety dialogues reinforces a collective sense of responsibility and shared commitment to risk reduction. As SMEs refine their training efforts to address specific vulnerabilities, they foster a more adaptive safety culture that aligns closely with both organizational goals and workforce needs (Hussain & Mackie, 2024).

Evaluation of OSHA System Efficiency

Examining the efficiency of OSHA management systems in SMEs requires attention to both organizational processes and measurable safety outcomes. Recent empirical research suggests

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that workplace safety improvements in SMEs are influenced by the degree to which OSHA-aligned practices are embedded within human resource policies, such as structured training programs and clear incident reporting procedures (Murugiah et al., 2024). In contexts where organizational attitudes and awareness regarding occupational safety are positive, there is typically a corresponding increase in compliance levels and a decrease in the number of reportable workplace accidents. Conversely, SMEs that exhibit less overt support from top management or have minimal hazard communication protocols often struggle to consistently meet OSHA standards, thereby limiting the overall impact of these systems on safety outcomes (Murugiah et al., 2024). Therefore, the efficient functioning of OSHA management systems appears to be contingent upon proactive organizational engagement, with leadership emphasizing a safety culture that catalyzes improved performance across small and mid-sized enterprises.

Assessing the cost-effectiveness of OSHA compliance for SMEs necessitates a careful evaluation of both direct and indirect expenditures associated with implementation. Direct costs commonly include expenses such as employee training, the acquisition of protective equipment, and updates to facility infrastructure, all of which are necessary to meet prescribed safety standards. Indirect costs, including productivity disruptions during training periods and the administrative burden of ongoing recordkeeping, also contribute to the financial impact of regulatory adherence. While some SMEs may regard these obligations as financially onerous, comparative research in micro-enterprises across different contexts demonstrates that structured safety management systems often correlate with reduced long-term incidence of workplace injuries and related losses (Bachtsetzis, 2020). Studies also highlight that small business owners/managers deem the moral aspects of OHS compliance most important, even though adherence to general safety regulations does not always reflect this (Esterhuyzen, 2022). Additionally, studies on public procurement indicate that as price competition increases (i.e., a lower bid-estimate ratio), accidents decrease, suggesting that efficient resource allocation can improve workplace safety. However, smaller firms may face challenges in investing in safety due to financial constraints (Hong et al., 2023). Research on the benefits of occupational safety and health interventions in small manufacturing enterprises suggests that advanced automation can reduce musculoskeletal disorder risk factors and improve productivity, offering a quantifiable return on investment (Lowe et al., 2022).

Moreover, measuring the benefits of OSH research often involves economic metrics such as costs saved and prevented injuries, which can be converted into dollar values to demonstrate the financial advantages of safety investments (Bushnell et al., 2022). This suggests that although initial outlays can be substantial, a well-implemented OSHA framework may offset future liabilities, supporting the economic sustainability of safety investments for SMEs. Consequently, empirical assessments in New York State SMEs consistently demonstrate that OSHA system implementation is associated with discernible declines in workplace accidents and injuries. Organizations adopting structured OSHA frameworks report improved hazard identification and more rigorous risk mitigation measures, resulting in safer environments for employees. Evidence also suggests that these benefits are most pronounced in enterprises prioritizing the involvement

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of both management and frontline staff in safety processes, reflecting the socially embedded nature of workplace risk dynamics (Ingram et al., 2021)

Notably, reductions in injury rates are observed across various sectors, but the gains are significant for low-wage and minority workers who disproportionately face hazardous occupational conditions. This convergence of regulatory compliance and participatory safety management highlights the potential of OSHA systems to address persistent disparities in occupational health outcomes among small and mid-sized businesses (Ingram et al., 2021). Nevertheless, several limitations and criticisms have emerged regarding the application of OSHA systems in SMEs, particularly in New York State. A major concern is the lack of uniformity in regulatory enforcement across the federal-state system, leading to varying degrees of worker protection by geographic location. This structure led to notable inconsistencies during crises such as the COVID-19 pandemic, underscoring persistent disparities in occupational safety oversight among SMEs (Grueskin, 2022). For instance, a study of the construction industry in New York State during the early stages of the COVID-19 pandemic found that firms in New York City had greater difficulty complying with increased health and safety regulations than those outside the city (Ilatova et al., 2022). Critics also argue that the complexity and resource demands of OSHA compliance may disproportionately strain smaller businesses, potentially creating barriers to the adoption of comprehensive systems. Such critiques suggest that, despite measurable reductions in workplace injuries, the current regulatory framework may not fully account for the operational realities and resource constraints unique to SMEs, prompting ongoing calls for reform and tailored policy interventions (Grueskin, 2022).

Alternatives to OSHA Management Systems

While OSHA provides a foundational regulatory framework for workplace safety, many SMEs in New York State pursue alternative systems such as ISO 45001 or industry-specific models. These systems emphasize the Plan-Do-Check-Act (PDCA) cycle, continuous improvement, and streamlined documentation—features that appeal to resource-constrained enterprises. Evidence from SMEs adopting ISO 45001 indicates that tailored protocols, simplified workflows, and externally supported implementation can lead to improved compliance and reductions in chemical and ergonomic risks. These outcomes mirror findings from broader international studies, which show that microenterprises benefit from frameworks that balance regulatory rigor with operational flexibility. Accordingly, alternative systems represent viable pathways for SMEs seeking a structured safety approach without the administrative complexity often associated with full OSHA integration.

On the other hand, several factors motivate SMEs in New York State to pursue alternatives to OSHA management systems rather than adhere to federally prescribed protocols. Many owners and managers perceive alternative frameworks as more flexible, allowing for the customization of safety strategies to address sector-specific risks and evolving workplace dynamics. Cost is another decisive element, as simplified procedures and reduced documentation demands associated with alternative systems often alleviate the financial and administrative burdens that

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OSHA compliance may impose on smaller enterprises. Additionally, alignment with business needs—such as favoring participatory approaches, streamlined information dissemination, and integration with return-to-work initiatives—has proven particularly advantageous for SMEs seeking to balance both operational efficiency and safety objectives simultaneously (Nastasia & Rives, 2024). Consequently, these considerations shape decision-making, with many SMEs opting for alternatives that offer greater adaptability without compromising core occupational health and safety priorities (Nastasia & Rives, 2024).

Variables Influencing OSHA System Adoption

Structural, organizational, and external factors shape the extent to which SMEs adopt OSHA management systems. Company size and sector risk level remain core determinants, with firms in construction, manufacturing, and chemical processing more likely to prioritize structured safety systems. Leadership commitment further influences adoption, as organizations with proactive, knowledge-centered managers tend to integrate more robust preventive practices. Resource availability—particularly time, personnel, and financial capacity—also plays a defining role in whether SMEs pursue comprehensive compliance or minimal adherence. External forces, including regulatory inspections and peer benchmarking, reinforce these internal dynamics by promoting the diffusion of best practices across sectors. Together, these variables shape both the likelihood and depth of OSHA system adoption among New York SMEs.

Additionally, the degree to which leaders acknowledge and address emerging technological and knowledge risks plays a substantial role in shaping organizational policies regarding OSHA compliance and the adoption of robust safety frameworks (Temel & Durst, 2021). Additionally, external factors such as regulatory enforcement and industry peer pressure play a substantial role in shaping the adoption rates of OSHA management systems among SMEs in New York State. Regulatory enforcement, including periodic inspections and the threat of citations, serves as an external motivator for organizations to adhere to prescribed safety standards, with compliance often more robust in sectors subjected to regular oversight. Industry peer pressure operates through benchmarking and competitive dynamics, in which firms seek not only to avoid penalties but also to align with prevailing safety performance norms within their fields (Barbosa et al., 2019). This collective behavior can promote the diffusion of best practices, as enterprises are motivated to adopt similar management standards for both reputational reasons and practical risk mitigation. Consequently, the interplay between formal regulatory mechanisms and the informal expectations of industry peers significantly influences SME decisions about the extent and rigor of occupational safety management system implementation (Barbosa et al., 2019).

Moreover, the internal dynamics of an organization—including its culture, level of employee involvement, and resource availability—profoundly shape the adoption and implementation of OSHA management systems within SMEs in New York State. Organizational culture significantly influences the prioritization of workplace safety, as environments that support open communication and shared responsibility tend to foster greater engagement with regulatory standards. Employee involvement, particularly through participatory approaches, enhances the

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effectiveness of safety initiatives by ensuring that risk-prevention strategies are relevant and consistently implemented across all levels of the business. Resource availability, encompassing both financial and personnel assets, determines whether comprehensive OSHA compliance can be achieved or if efforts are limited to minimal requirements. These internal factors interact to produce varying degrees of OSHA system adoption, highlighting that effective occupational safety practices in SMEs are as dependent on organizational context as they are on external regulatory pressures.

Comparative Analysis of Safety Practices

In comparing safety practices among SMEs that employ OSHA systems with those that use alternative or informal frameworks, notable distinctions emerge in structure, consistency, and operational focus. OSHA-compliant SMEs are typically characterized by more systematic safety protocols, detailed accident investigations, and formalized processes for continuous improvement, which collectively contribute to more uniform implementation of preventive measures. Alternatively, SMEs that adopt informal or non-OSHA approaches tend to demonstrate greater flexibility, often adapting safety practices to address immediate concerns and resource constraints rather than adhering to standardized protocols (Wöll & Sulíková, 2023). While this flexibility can facilitate responsive decision-making, it may lead to fragmented hazard management and fewer opportunities for organizational learning from workplace incidents. On balance, the structured nature of OSHA systems often provides more reliable safeguards.

In contrast, alternative or informal strategies may offer greater adaptability but may come at the expense of sustained injury reduction and preventive consistency (Wöll & Sulíková, 2023). As a result, the differential adoption of structured OSHA systems and alternative safety practices among SMEs has produced measurable differences in accident rates, employee satisfaction, and regulatory compliance. OSHA-aligned organizations tend to report lower incident frequencies, in part due to systematic reporting mechanisms and the consistent application of preventive controls. Conversely, enterprises that adopt less formal frameworks may experience uneven results, as flexibility in safety program execution can lead to gaps in hazard management and follow-up procedures. Importantly, models that integrate participatory methods and active knowledge acquisition have been linked to superior employee satisfaction and smoother reintegration following occupational injuries, primarily when they reflect the unique environment of each enterprise (Nastasia & Rives, 2024). In terms of regulatory compliance, firms with comprehensive, information-driven safety management achieve more consistent adherence to legal standards, reflecting the relevance of customized strategies for sustainable occupational health outcomes within the diverse sector of New York State SMEs (Nastasia & Rives, 2024).

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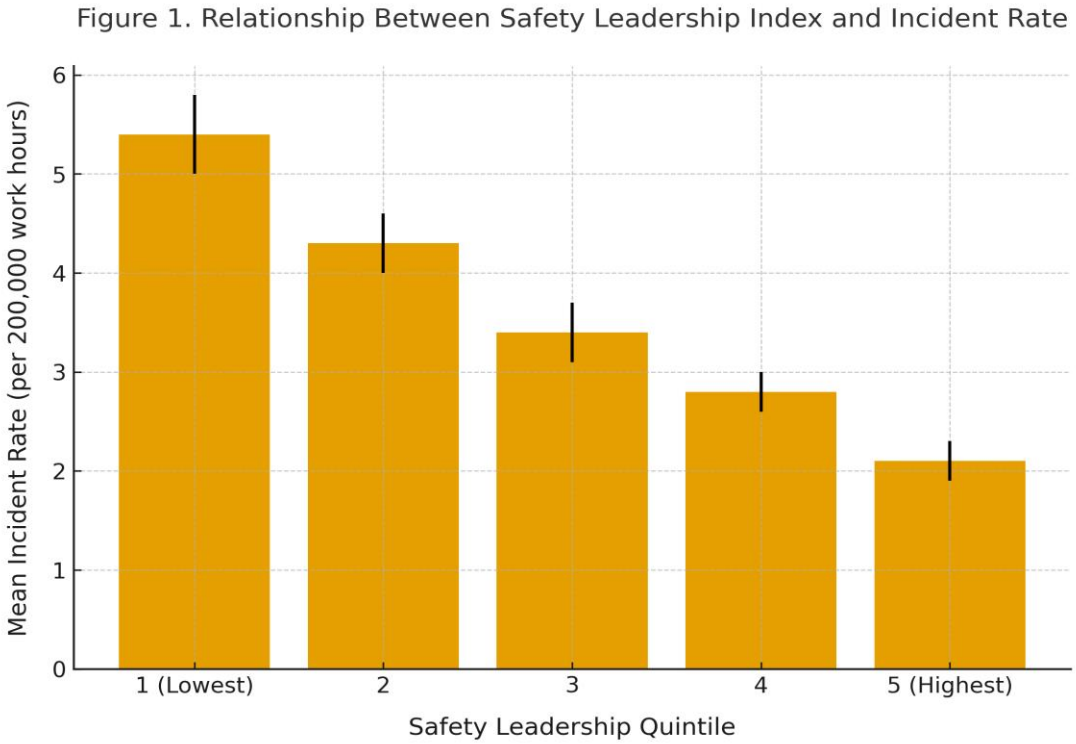
Figure 1. *Bivariate relationship between safety leadership and TRIR per 200,000 hours (slope = −0.48, p < .001).*



Note. Bars show mean incident rate by quintiles of Safety Leadership Index; error bars represent 95% confidence intervals. The slope (−0.48, p < .001) is bivariate; the adjusted coefficient is −0.52 (Table 2). Sample includes 200 New York SMEs (2024). Incident rate = OSHA recordables per 200,000 hours.

For illustrative purposes, several New York State SMEs demonstrate distinct approaches to occupational safety and health management, yielding varied results. One manufacturing firm implemented an alternative management system utilizing the Plan-Do-Check-Act (PDCA) cycle, which facilitated streamlined documentation and continuous safety improvements adapted to their operational needs (Jaroenroy, 2019). In contrast, a logistics SME relied predominantly on informal, experience-based practices, prioritizing immediate hazard response but struggling to maintain consistent preventive standards over time. Another enterprise, operating in the food processing sector, adopted elements from integrated occupational health, safety, and environmental frameworks. Drawing on external consultation and targeted employee training, it aligned safety protocols with regulatory requirements and industry best practices (Jaroenroy, 2019). Collectively, these examples underscore how the selection and adaptation of occupational safety systems significantly affect both organizational workflow and outcomes, reflecting broader trends in resource allocation, stakeholder involvement, and external support.

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Discussion

Leadership and resource allocation are the most consistent correlations of lower incident rates among New York SMEs. Training adequacy, while weaker, aligns directionally. These results reinforce prior findings emphasizing leadership visibility and participatory safety mechanisms as drivers of organizational safety performance. Results underscore scalable, leadership-centered OSH models adaptable to SME contexts.

Practical Implications for Small and Mid-Size Enterprises

Findings from this study translate into several actionable strategies that SME owners, managers, and safety coordinators can implement with minimal disruption to operations. First, strengthening visible safety leadership should be prioritized. Leadership walkarounds, open-door communication about hazards, and consistent messaging regarding safety expectations create a more proactive reporting climate. Second, SMEs can adopt lightweight digital reporting systems—such as mobile applications or simplified dashboards—to streamline hazard identification and improve the timeliness of corrective actions. Third, allocating even modest increases to OSH budgets can yield meaningful reductions in incident rates; investments may include purchasing fundamental protective equipment, supporting periodic refresher training, or funding part-time safety coordinators. Fourth, SMEs can establish or revitalize participatory safety committees that emphasize collaborative decision-making and employee involvement. Finally, embedding short, quarterly micro-trainings enhances hazard awareness without the burden of extended training sessions. Collectively, these strategies offer cost-efficient avenues for strengthening safety systems in resource-constrained environments.

Limitations

This study's cross-sectional design limits causal inference; measures rely partly on self-report; and microenterprises (<10 employees) are underrepresented. Future longitudinal and quasi-experimental studies are recommended to evaluate causal pathways and the durability of interventions.

Future Research

This study acknowledges several limitations that warrant consideration for future research. The reliance on self-reported incident data from SMEs introduces potential for response bias, as managers might underreport incidents to present a more favorable safety record. Future studies could mitigate this by incorporating objective data sources, such as workers' compensation claims or OSHA inspection records, where available and anonymized. Additionally, the cross-sectional design limits the ability to establish causal relationships between the implementation of OSH systems and long-term safety outcomes. Longitudinal studies tracking safety investments and incident rates over extended periods would provide a more robust understanding of efficiency and impact. The generalizability of these findings, while focused on New York State SMEs, may also be limited to other geographical regions or larger enterprises with different

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regulatory landscapes and resource capacities. Future research should explore the applicability of these findings in diverse contexts.

Future research directions could also explore the effectiveness of specific training interventions and their impact on employee engagement and safety culture within SMEs. Investigating the role of advanced automation in reducing musculoskeletal disorder risks and improving productivity in small manufacturing enterprises, as suggested by recent literature (Lowe et al., 2022), could offer quantifiable returns on investment. Furthermore, a deeper dive into the economic metrics of costs saved and injuries prevented, converting these into dollar values, would provide a more comprehensive cost-benefit analysis of OSH interventions (Bushnell et al., 2022). Finally, exploring the influence of state-specific policies and outreach programs on OSHA adoption rates and safety outcomes in New York State SMEs would provide valuable insights for tailored policy development.

Conclusion

This study demonstrates that occupational safety outcomes among New York State SMEs are closely linked to visible leadership engagement and strategic allocation of OSH resources. Safety leadership and proportional budgeting were the most consistent predictors of lower incident rates, while training adequacy showed a positive but marginal association. These findings reinforce prior research emphasizing leadership-driven safety climates and extend the literature by quantifying the relative effect sizes of leadership, training, and resource allocation within SMEs operating across diverse sectors in New York State. This contribution is particularly notable given the limited empirical work applying mixed-methods approaches to OSH efficiency in small enterprises.

The study further highlights that both OSHA-aligned and alternative safety systems can be effective when aligned with organizational context and capacity. Structured OSHA frameworks offer consistency and formal risk management processes, whereas frameworks such as ISO 45001 provide adaptable pathways for smaller firms seeking greater operational fit. Policymakers and practitioners should prioritize initiatives that cultivate leadership capacity, strengthen reporting climates, and support SMEs with targeted resources. By combining regulatory standards with flexible implementation options, safety outcomes within New York's SME sector can be sustainably improved.

Declarations

Funding: This research received no external funding. **Author contributions (CRediT)**: Dr Robb Shawe – Conceptualization, methodology, analysis, writing, visualization, and project administration. **Data availability**: Anonymized dataset and code available upon reasonable request; raw data restricted by organizational agreements. **Ethical approval**: Capitol Technology University IRB (IRB# CTS-OSH-25-042). **Conflict of interest**: None declared.

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Highlights

- Stronger safety leadership is linked to lower TRIR in New York SMEs.
- +1% OSH budget share relates to modest TRIR reduction (adjusted models).
- Training adequacy shows a positive but non-significant trend (p = .078).
- Models explain ~44% of incident-rate variance (N = 200).
- Scalable, leadership-driven OSH strategies for SMEs.

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