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[4]Contractor Safety Performance Evaluation Using Key Safety Indicators in Construction and Process Industries

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1 Abstract

Contractors execute a large share of high-risk construction, maintenance, shutdown, turnaround, and plant-modification work. Their performance therefore affects both occupational safety and, in process facilities, the prevention of major hazardous events. This descriptive paper examines contractor safety performance evaluation using a balanced set of key safety indicators. It explains the role of lagging indicators such as injury and incident rates and leading indicators such as management engagement, training, risk assessment, permit compliance, inspections, near-miss reporting, and corrective-action closure. The paper compares the priorities of construction and process industries and proposes an integrated approach covering prequalification, field execution, periodic review, and close-out. The central argument is that contractor safety cannot be judged reliably from accident statistics alone; meaningful evaluation requires verified leading and lagging indicators that reflect both safety-management capability and actual outcomes.

Keywords: contractor safety, safety performance evaluation, key safety indicators, leading indicators, lagging indicators, construction safety, process safety, contractor prequalification, safety management.

2. Introduction

Construction and process industries depend on contractors for civil works, erection, scaffolding, electrical work, mechanical maintenance, welding, confined-space entry, shutdowns, and specialist activities. Because contractor personnel often work beside the host employer and other contractors, differences in competence, supervision, communication, and work methods can create interface risk. OSHA guidance therefore emphasizes communication of hazards, coordination of responsibilities, and consideration of safety qualifications during contractor selection and work planning (OSHA, 2016). (OSHA)

Many organizations still judge contractor safety mainly through recordable injuries, lost-time cases, severity rates, and compensation experience. These lagging measures are useful but reactive and may be misleading for small contractors or short projects. OSHA describes leading indicators as proactive and preventive measures that can reveal weaknesses before injuries occur (OSHA, 2019). In process industries, OSHA's Process Safety Management standard goes further by requiring host employers to obtain and evaluate contractor safety performance and programs, periodically evaluate contractor performance, and maintain contractor injury and illness information for relevant process-area work. (OSHA)

Contractor Safety Performance as a Management Requirement

Contractor safety performance evaluation is a management process used to determine whether a contractor has the systems, people, and behaviors needed to control the risks of a specific scope of work. Evaluation should begin during prequalification and continue through mobilization, execution, and project close-out. Ng, Cheng, and Skitmore (2005) showed that structured contractor safety evaluation can support benchmarking and management decisions. The evaluation should therefore consider organizational capability—policy, competence, training, supervision, and previous performance—together with project-level evidence such as hazard control, inspections, compliance, and corrective action.

Key Safety Indicators: Leading and Lagging Measures

Lagging indicators describe events that have already occurred, including recordable injuries, lost-time cases, severity, property damage, vehicle incidents, environmental releases, and regulatory violations. They confirm outcomes but do not explain whether preventive systems are working. Hinze, Thurman, and Wehle (2013) distinguished these outcome measures from construction leading indicators that reflect the safety process.

Leading indicators measure the actions and conditions that influence future performance. Typical contractor indicators include management safety interactions, induction and competency completion, quality of job hazard analyses, pre-task planning, permit-to-work compliance, inspections, unsafe-condition reporting, near-miss reporting, preventive maintenance, emergency drills, and corrective-action closure. OSHA (2019) recommends connecting such indicators to leadership, worker participation, hazard identification, hazard control, training, program evaluation, and contractor coordination. A balanced scorecard therefore uses leading measures to drive prevention and lagging measures to test results.

Contractor Prequalification and Safety Capability

Prequalification is the first formal control point. The client can review injury history, regulatory notices, safety procedures, competent-person arrangements, training records, risk-assessment methods, emergency preparedness, equipment inspection, and subcontractor control. Process facilities should also consider experience with permit systems, energy isolation, confined-space entry, hot work, line breaking, and turnarounds. Liang, Zhang, and Su (2018) found that management commitment, training and education, risk management, and safety rules and procedures were among the most influential factors in safe-contractor selection, supporting the use of both historical outcomes and capability indicators.

Key Safety Indicators in Construction Projects

Construction sites change rapidly as crews, work fronts, access, temporary works, equipment, and interfaces evolve. Useful leading indicators include the quality of pre-task plans, toolbox participation, fall-protection compliance, scaffold inspections, lifting-plan compliance, housekeeping, excavation controls, electrical safety, supervisor coverage, hazard observations, and closure time for high-risk findings. Xu et al. (2021) identified a broad system of construction leading indicators, while Xu et al. (2022) highlighted organizational commitment, stakeholder engagement, training, safety climate, and competence as critical implementation areas. These findings support project scorecards that measure leadership, planning, workforce capability, and field control together with injury performance.

Process Industry Indicators and Process Safety

Process industries require additional indicators because contractor work can disturb hazardous systems or weaken critical barriers even without a personal injury. Maintenance, turnaround, welding, vessel entry, line opening, and electrical isolation can interact with flammable, toxic, reactive, or high-energy materials. Contractor metrics should therefore include permit-to-work quality, isolation verification, gas testing, confined-space controls, hot-work authorization, line-breaking practices, emergency preparedness, and adherence to facility safe-work procedures. OSHA's PSM contractor provisions specifically address contractor selection, hazard communication, safe work practices, periodic evaluation, and contractor training responsibilities.

The CCPS Process Safety Metrics Guide uses a tiered approach that separates major process events from lower-level warning signals and management-system indicators. API Recommended Practice 754 provides a related standardized framework for refining and petrochemical operations. For contractor evaluation, these approaches help distinguish occupational safety from process safety. A contractor may have a low personal-injury rate while still showing serious weaknesses in work permits, isolation, operating discipline, or barrier protection. Hopkins (2009) similarly cautioned against treating personal injury statistics as an adequate substitute for process-safety performance.

Integrated Contractor Safety Performance Evaluation Framework

An integrated framework can organize indicators into five domains: safety leadership and management commitment; workforce competence and participation; hazard identification and risk control; compliance, assurance, and corrective action; and safety outcomes. Construction projects can emphasize fall prevention, lifting, excavation, mobile equipment, and temporary works, while process plants can give additional emphasis to permits, isolations, confined spaces, line breaking, and process-safety events. The indicator set should be risk-based so that measures linked to the actual work scope carry more influence than generic activity counts.

Each KPI should have a clear definition, data source, reporting frequency, target, and responsible owner. Values can be normalized and combined into a composite contractor score using weights selected according to risk and organizational priorities. Daily or weekly reviews can detect permit deviations, overdue actions, and repeated unsafe observations; monthly reviews can examine training, inspection, near-miss, and injury trends; and close-out reviews can feed verified performance back into future prequalification. The score should support professional judgment rather than replace it.

Audits, Near-Miss Reporting and Corrective-Action Closure

Audits and inspections are most useful when the scorecard measures quality and follow-through, not only the number completed. Relevant indicators include completion to plan, repeat findings, high-risk findings, closure within target time, and recurrence after closure. Near-miss reports provide learning signals when they are investigated according to potential severity and linked to management-system weaknesses. CCPS also emphasizes learning from near misses and relating them to weaknesses in the management system. Corrective-action closure is especially important because identified hazards do not reduce risk until the required control is implemented and verified.

Challenges in KPI-Based Evaluation

Indicators can create false confidence when definitions are inconsistent, exposure data are poor, reporting is discouraged, or metrics become targets in themselves. Contractors may under-report minor events to protect their rating, while clients may compare firms with very different risk profiles. A practical system should therefore use a limited set of meaningful KPIs, normalize rates where appropriate, verify data through field assurance, and interpret trends in the context of work hours, task complexity, and major-hazard exposure.

Literature review

1. Leading and Lagging Indicators

Hinze et al. (2013) distinguished proactive construction safety measures from injury outcomes, and OSHA (2019) recommends using leading indicators to drive preventive action while lagging indicators measure results.

2. Contractor Safety Evaluation

Ng et al. (2005) proposed a construction contractor safety performance framework that supports organizational and project-level evaluation, benchmarking, and management decisions.

3. Safe Contractor Selection

Liang et al. (2018) integrated leading and lagging indicators for contractor prequalification and emphasized management commitment, training, risk management, and safety procedures as major influences on safety capability.

4. Construction Leading Indicators

Xu et al. (2021, 2022) showed that leading-indicator systems are strengthened by organizational commitment, stakeholder engagement, training, competence, and safety climate rather than by isolated activity counts.

5. Process Safety Metrics

CCPS (2022) and API (2022) use tiered process-safety measurement approaches that distinguish serious process events from lower-level warning signals and management-system indicators, providing a useful basis for high-hazard contractor oversight.

6. Research Direction

Further research is needed to validate contractor KPI weightings across industries, account for different exposure profiles, improve subcontractor and digital-data quality, and test whether composite scores predict future safety performance across multiple projects.

Conclusion:

Contractor safety performance evaluation is strongest when it examines both actual outcomes and the quality of the systems that create safe work. Lagging indicators remain necessary, but leading indicators such as leadership engagement, competency, risk assessment, permit compliance, inspections, worker reporting, near-miss learning, and corrective-action closure provide earlier evidence of preventive control. In construction, these measures help manage changing work fronts and multiple interfaces; in process industries they must be supplemented with process-safety indicators addressing hazardous-work controls, isolation, containment, and critical barriers.

A balanced contractor scorecard should therefore combine verified leading and lagging indicators, align them with the scope and risk of the work, and review them throughout the contractor life cycle. When the results influence corrective actions, contractor continuation, future selection, and organizational learning, KPIs become a practical mechanism for improving contractor capability and reducing both occupational and major-hazard risk.

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