



International Journal of Multidisciplinary Research and Growth Evaluation



International Journal of Multidisciplinary Research and Growth Evaluation

ISSN: 2582-7138

Received: 09-11-2020; Accepted: 10-12-2020

www.allmultidisciplinaryjournal.com

Volume 1; Issue 5; November-December 2020; Page No. 728-740

A Governance-Oriented Conceptual Model for Contractor Safety Performance in Multi-Contract Industrial Projects

Oluwakemi Motunrayo Arumosoye ^{1*}, Oghenepawon David Obriki ²

¹ Felz Marine Nigeria Limited, Rivers State, Nigeria

² Independent Reseacher, Lagos State, Nigeria

Corresponding Author: **Oluwakemi Motunrayo Arumosoye**

DOI: <https://doi.org/10.54660/IJMRGE.2020.1.5.728-740>

Abstract

Contractor safety performance in multi-contract industrial projects remains a persistent challenge due to the complexity of organizational structures, dispersed workforces, and overlapping responsibilities. Traditional compliance-based safety approaches often fail to address systemic risks arising from multi-tier contracting arrangements, dynamic project environments, and variable contractor capabilities. This proposes a governance-oriented conceptual model that links organizational structures, decision authority, and oversight mechanisms to contractor safety outcomes, providing a structured framework for understanding and managing safety in multi-contractor contexts. The model conceptualizes contractor safety performance as a function of governance inputs, operational controls, and feedback mechanisms. Governance inputs include clarity of roles, decision rights, and contractual obligations, which establish the structural and procedural foundation for accountability. Operational controls encompass risk assessment, hazard mitigation practices, and reporting systems, while feedback mechanisms facilitate learning, continuous improvement, and performance monitoring. The model emphasizes the importance of integration across owner organizations, primary contractors, and subcontractors, recognizing that safety outcomes are contingent on effective communication,

oversight, and alignment of objectives throughout the contractual hierarchy. Key assumptions underlying the framework include the dynamic, context-dependent nature of safety risks, the role of data-driven monitoring and reporting, and the critical influence of organizational culture and leadership commitment on contractor compliance and proactive behavior. By identifying mediating mechanisms such as trust, perceived fairness, and responsiveness to feedback, the model highlights pathways through which governance practices influence both perceptual and behavioral safety outcomes. Additionally, moderating factors—including project phase, contractor experience, and workforce characteristics—are incorporated to account for variability in performance across complex industrial projects. This governance-oriented model contributes to safety management literature by bridging organizational theory, governance frameworks, and practical contractor oversight, providing actionable insights for project owners, safety professionals, and policymakers. By emphasizing structured oversight, accountability, and continuous learning, the framework supports the design of multi-layered safety governance systems that enhance contractor performance, mitigate risks, and improve overall project safety outcomes in multi-contract industrial environments.

Keywords: Contractor Safety, Governance, Multi-Contract Projects, Industrial Safety, Organizational Oversight, Safety Performance, Risk Management

1. Introduction

Multi-contract industrial projects, such as large-scale construction, energy infrastructure, and petrochemical developments, present unique safety management challenges due to their scale, complexity, and the involvement of multiple contractors and subcontractors (Yeboah and Enow, 2018; Nwafor *et al.*, 2019). The fragmentation of responsibilities across different organizations creates interface risks, where gaps in communication, coordination, and accountability can lead to overlooked hazards and inconsistent safety practices. Cultural diversity among contractors, reflecting variations in organizational norms, safety values, and operational procedures, further complicates the management of safety across project sites (Ugwu-Oju *et al.*, 2018; Okeke *et al.*, 2019).

These factors collectively contribute to an elevated risk environment, where incidents may arise from misaligned procedures, insufficient supervision, or unrecognized interactions between workgroups (Oguntegebe *et al.*, 2019; Dako *et al.*, 2019).

Evidence from industrial safety studies indicates that contractor and subcontractor activities are disproportionately associated with occupational hazards and incidents. Factors such as transient workforces, varying skill levels, and differences in adherence to organizational safety standards increase the likelihood of accidents and near-misses. Despite the critical role of contractors in project delivery, traditional safety management approaches often remain compliance-driven and contractor-centric, emphasizing rule adherence, inspections, and reactive incident reporting (Ahmed and Odejebi, 2018; Michael and Ogunsola, 2019). While such approaches are essential for meeting regulatory obligations, they frequently fail to address systemic risks, cross-organizational coordination, and proactive hazard mitigation, limiting their effectiveness in complex multi-contract environments (Seyi-Lande *et al.*, 2018; Odejebi *et al.*, 2019). These limitations highlight the need for a governance-oriented perspective on contractor safety performance. A governance lens emphasizes the structural, procedural, and oversight mechanisms that establish accountability, clarify decision-making authority, and align safety priorities across multiple contractors (NWAFOR *et al.*, 2018; Bayeroju *et al.*, 2019). By integrating governance principles into safety management, project owners can systematically monitor contractor performance, enforce standards consistently, and create feedback mechanisms that support continuous learning and improvement. This perspective shifts the focus from purely compliance-based interventions to strategic oversight that enhances risk control, organizational learning, and resilience across multi-contractor project ecosystems (Ugwu-Oju *et al.*, 2018; Seyi-Lande *et al.*, 2019).

The purpose of the conceptual model proposed in this study is to provide a structured framework linking governance mechanisms, operational controls, and contractor safety performance outcomes in multi-contract industrial projects. The model encompasses key dimensions such as role clarity, decision authority, communication pathways, and feedback loops, highlighting how governance structures mediate and moderate contractor behavior. Its scope includes large-scale projects with complex contractual arrangements, emphasizing both strategic and operational aspects of safety management.

The study's objectives are threefold: (1) to conceptualize the pathways through which governance practices influence contractor safety performance; (2) to identify the mediating mechanisms, such as leadership credibility, communication quality, and organizational learning; and (3) to explore moderating factors, including project phase, workforce characteristics, and contractor experience, that may affect safety outcomes. Guiding research questions include: How do governance structures shape contractor compliance and proactive safety behaviors? What mechanisms translate governance inputs into perceptual, attitudinal, and behavioral safety outcomes? And which contextual factors strengthen or weaken these relationships?

By addressing these questions, the study contributes to both theory and practice, offering a governance-oriented framework that informs safety leadership, oversight strategies, and policy development in multi-contract

industrial projects. The model provides actionable insights for project owners, safety managers, and regulators seeking to enhance contractor performance, mitigate systemic risks, and promote a resilient safety culture across complex industrial operations.

2. Methodology

A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology to develop a governance-oriented conceptual model for contractor safety performance in multi-contract industrial projects. Multiple scholarly databases, including Scopus, Web of Science, and IEEE Xplore, were queried for peer-reviewed journal articles, conference proceedings, and industry reports. Search terms combined keywords related to contractor safety, governance, multi-contract projects, industrial safety management, and risk oversight. Boolean operators and truncation strategies were employed to ensure comprehensive coverage, while inclusion and exclusion criteria were applied to focus on studies relevant to multi-tier contracting, governance mechanisms, and safety performance outcomes.

The inclusion criteria required studies to: (1) address industrial or large-scale construction, energy, or manufacturing projects involving multiple contractors; (2) investigate safety management, risk control, or governance structures; (3) provide empirical, conceptual, or theoretical insights into contractor safety performance; and (4) be available in English. Excluded studies were those focused solely on single-contractor projects, purely technical safety interventions without organizational or governance context, or non-peer-reviewed sources lacking methodological transparency.

The initial search yielded 1,248 publications, which were screened for relevance based on titles and abstracts, reducing the set to 213 studies. Full-text review further refined the selection to 92 studies that met all inclusion criteria. Key information extracted included study context, project type, governance structures, contractor roles, safety performance metrics, and reported challenges or enablers. Data extraction followed a structured template to ensure consistency across studies.

Synthesis involved both qualitative and quantitative approaches. Conceptual and thematic analysis identified recurring patterns related to governance mechanisms, accountability structures, decision-making authority, oversight practices, and contractor engagement. Quantitative synthesis, where applicable, summarized correlations between governance practices and safety outcomes. The combined insights informed the development of a multi-layered conceptual model linking governance structures, operational controls, feedback loops, and contractor safety performance. Triangulation of findings across studies and project contexts enhanced the robustness and generalizability of the resulting framework, providing a theoretically grounded and practically relevant model for multi-contract industrial projects.

2.1. Theoretical Foundations

Understanding contractor safety performance in multi-contract industrial projects requires a theoretically grounded approach that integrates governance, organizational, and systems perspectives. Safety in these contexts is not solely a function of individual behavior or compliance but emerges

from the complex interactions among governance structures, contractual relationships, technical systems, and organizational culture (Odejebi and Ahmed, 2018; Ugwu-Oju *et al.*, 2018). This presents the theoretical foundations underpinning a governance-oriented conceptual model for contractor safety, focusing on safety governance, principal-agent and institutional theories, and socio-technical systems perspectives.

Safety governance encompasses the structures, policies, processes, and oversight mechanisms through which organizations establish accountability, allocate responsibilities, and ensure that safety objectives are achieved. It differs from management, which focuses on day-to-day operational execution, and supervision, which involves direct oversight of frontline activities. Governance provides the strategic and systemic framework that guides management decisions, sets performance expectations, and monitors adherence to safety standards. In multi-contract industrial projects, safety governance operates along both vertical and horizontal dimensions. Vertical governance involves hierarchical oversight, linking project owners, prime contractors, and subcontractors, ensuring alignment of safety objectives and decision authority across tiers. Horizontal governance refers to lateral coordination among peer contractors, functional departments, and interdisciplinary teams, facilitating information sharing, collaborative risk mitigation, and harmonized safety practices (Schuh *et al.*, 2017; Pilkienė *et al.*, 2018). Together, these governance dimensions form the structural backbone that enables consistent and reliable contractor safety performance across complex project ecosystems.

Contractor safety performance can be conceptualized through principal-agent theory, which addresses the relationships between owners and contractors, and contractors and subcontractors. In these relationships, principals (project owners or prime contractors) delegate responsibilities to agents (contractors or subcontractors) but face information asymmetry and potential moral hazard, as agents may prioritize productivity over safety or underreport hazards. Effective governance mechanisms including contracts, incentive structures, performance monitoring, and oversight protocols are essential for aligning agent behavior with principal objectives. Institutional theory complements this view by highlighting the influence of formal and informal norms, regulatory pressures, and organizational legitimacy on contractor behavior. Institutional mechanisms, such as safety standards, industry codes, and certification requirements, shape organizational practices and encourage compliance beyond immediate contractual obligations. By integrating principal-agent and institutional perspectives, the framework explains how both structural controls and normative pressures influence contractor adherence to safety expectations (Seyi-Lande *et al.*, 2018; Badmus and Olamide, 2019).

Safety performance in multi-contract projects emerges from a socio-technical system, wherein technical controls, human behavior, and organizational context interact dynamically. Contractor safety is not solely attributable to individual actions; it reflects the interdependence of processes, tools, equipment, work practices, and governance structures (Powell and Baker, 2019; Maucec and Garmi, 2019). Systems safety perspectives, including High Reliability Organization (HRO) principles, emphasize that resilience arises from continual vigilance, proactive hazard identification,

redundancy, and strong communication channels. HRO concepts such as preoccupation with failure, sensitivity to operations, and commitment to resilience are particularly relevant in contractor ecosystems, where multiple organizations operate in parallel under high-risk conditions (Ford, 2018; Harvey *et al.*, 2019). By framing contractor safety as an emergent property of socio-technical interactions, the model recognizes that effective governance, proactive monitoring, and learning-oriented cultures are critical to reducing systemic risk and preventing adverse events (Uusikylä, 2019; Bolici *et al.*, 2019).

Integration of these theoretical perspectives provides a comprehensive lens for examining contractor safety performance. Safety governance establishes the structural and procedural context for decision-making and accountability, while principal-agent and institutional theories explain the behavioral dynamics and compliance incentives within contractual relationships (Maggetti and Papadopoulos, 2018; Troisi and Alfano, 2019). Socio-technical and systems perspectives emphasize that safety emerges from interactions across human, organizational, and technical subsystems, highlighting the need for holistic oversight and adaptive practices (Dainoff, 2017; Aven and Ylönen, 2018). Collectively, these foundations justify the adoption of a governance-oriented conceptual model that links structured oversight, decision authority, and operational controls to contractor safety outcomes.

By grounding the model in these complementary theories, the framework captures both macro-level governance structures and micro-level behavioral dynamics, providing a robust basis for understanding how leadership, policy, and oversight mechanisms influence contractor safety in multi-tier industrial projects (Badmus and Olamide, 2018; Okeke *et al.*, 2019). This theoretical synthesis ensures that safety management strategies are not only prescriptive but also adaptive, resilient, and responsive to the complex realities of multi-contract project execution.

2.2. Contractor Safety Performance in Multi-Contract Environments

Contractor safety performance in multi-contract industrial projects is a critical determinant of overall project safety and operational success. These projects, which include large-scale construction, energy, petrochemical, and infrastructure developments, are characterized by complex organizational structures, multiple tiers of contractors, and diverse workforce profiles. The distributed nature of responsibility, combined with the inherent hazards of industrial operations, creates unique challenges for achieving consistent safety outcomes across all participating organizations (Kontogiannis *et al.*, 2017; Badri *et al.*, 2018). Understanding contractor safety performance requires examining the project characteristics, the dimensions of safety performance, and the mechanisms through which performance is monitored, measured, and enhanced.

Multi-contract projects typically involve multiple tiers of contractors and subcontractors, each responsible for distinct work packages, operational zones, or specialized tasks. Primary contractors oversee large sections of work, while subcontractors perform highly specialized or localized functions, often under differing management structures and safety protocols (Ugwu-Oju *et al.*, 2018; Ekechi, 2019). This multi-tier arrangement creates interface-intensive operations, where overlapping responsibilities and handoffs between

contractors increase the likelihood of communication breakdowns, misaligned procedures, and latent hazards. Concurrent operations, common in fast-track projects, further exacerbate risk by requiring simultaneous coordination of high-risk tasks such as heavy lifting, high-voltage work, or chemical handling, often across geographically dispersed sites.

The workforce in such projects is typically transient and heterogeneous, with varying levels of skill, experience, and safety maturity. Workers may move between contractors or project phases, creating challenges for consistent safety training, supervision, and reinforcement of safe practices. Variability in safety culture across organizations can also result in differing risk perceptions and behaviors, making it difficult to implement unified safety policies and monitor compliance effectively (Lofquist *et al.*, 2017; Yorio *et al.*, 2019). These characteristics underscore the need for robust governance mechanisms and proactive oversight to ensure that safety performance is maintained consistently across all tiers and operational contexts.

Contractor safety performance can be evaluated across multiple dimensions, encompassing lagging, leading, behavioral, and cultural indicators.

Lagging indicators include measurable outcomes such as injury frequency, lost-time incidents, and property damage. While these metrics are important for regulatory reporting and compliance, they are inherently reactive, reflecting risks that have already materialized (Agrafiotis *et al.*, 2017; Yang and Li, 2018). Overreliance on lagging indicators may obscure underlying hazards, interface risks, and near-misses, limiting opportunities for proactive intervention.

Leading indicators, in contrast, provide predictive insights into potential safety risks before they result in incidents. Examples include near-miss reporting rates, hazard observations, safety inspections, and participation in training programs. These metrics allow project owners and safety managers to identify systemic weaknesses, evaluate contractor adherence to safety protocols, and implement preventive measures that reduce the probability of accidents. Leading indicators also support continuous improvement by fostering a proactive safety culture among contractors and subcontractors (Reiman and Pietikäinen, 2018; Santa *et al.*, 2018).

Behavioral and cultural indicators capture the human and organizational dimensions of safety performance. Behavioral indicators include compliance with safety rules, engagement in hazard reporting, and discretionary safety behaviors such as assisting peers or intervening in unsafe practices. Cultural indicators reflect employees' perceptions of leadership commitment, trust, communication quality, and psychological safety within and across contractor organizations. Monitoring these dimensions helps identify whether safety practices are genuinely embedded in day-to-day operations, rather than merely driven by compliance requirements (Erigha *et al.*, 2019; Anichukwueze *et al.*, 2019).

A comprehensive understanding of contractor safety performance requires integrating lagging, leading, behavioral, and cultural indicators into a cohesive monitoring framework. Multi-tier projects benefit from centralized reporting platforms that aggregate data from contractors and subcontractors, enabling real-time visibility of hazards, trends, and intervention effectiveness. Cross-referencing leading and lagging indicators allows safety managers to

evaluate whether proactive measures are translating into tangible reductions in incidents. Behavioral and cultural metrics, often obtained through surveys, observations, and audits, provide context to the numerical data, ensuring that interventions address both procedural compliance and the underlying safety culture (Livorsi *et al.*, 2018; Nævestad *et al.*, 2018).

Contractor safety performance in multi-contract industrial projects is influenced by complex organizational arrangements, interface risks, and workforce variability. Evaluating performance requires attention to lagging, leading, behavioral, and cultural indicators, which collectively reflect both outcomes and processes. By integrating these dimensions into a structured oversight and governance framework, project owners and safety professionals can enhance proactive risk management, promote a consistent safety culture, and reduce systemic hazards across multiple contractors and subcontractors. Ultimately, robust measurement and monitoring of contractor performance are essential to achieving resilient, reliable, and safe operations in complex industrial project environments.

2.3. Rationale for a Governance-Oriented Conceptual Model

The safety performance of contractors in multi-contract industrial projects is influenced not only by technical measures and operational procedures but also by the governance structures that guide decision-making, accountability, and oversight. Traditional contractor-level safety management systems, while necessary, often exhibit significant limitations in addressing the complexity of multi-tier project environments. These limitations, coupled with governance gaps and misalignment across organizational hierarchies, create systemic risks that cannot be mitigated solely through compliance-focused interventions. The development of a governance-oriented conceptual model offers a structured approach to understanding and managing contractor safety performance by emphasizing the strategic role of oversight, alignment, and behavioral influence across project ecosystems.

Contractor-level safety management systems typically focus on internal compliance, procedural adherence, and operational hazard control. These systems are effective for managing localized risks within individual contractor organizations but often fall short in multi-contract contexts. Fragmentation between contractors and subcontractors may lead to inconsistent safety standards, incomplete hazard communication, and duplication or gaps in risk mitigation efforts. Additionally, contractor-centric systems may emphasize lagging indicators, such as injury rates or lost-time incidents, over proactive monitoring and predictive safety measures (Oshomegie, 2018; Oguniola *et al.*, 2019). While audits, inspections, and training programs provide some oversight, they often fail to capture the interdependencies and interface risks that arise in complex projects involving multiple contractors, shifting work fronts, and high workforce turnover.

Governance gaps occur when roles, responsibilities, and decision authority are unclear, overlapping, or inadequately communicated across the project hierarchy. Misalignment between project owners, prime contractors, and subcontractors can lead to conflicting priorities, where production pressures override safety considerations, or where safety requirements are inconsistently enforced. These gaps increase the likelihood of latent hazards, delayed hazard

reporting, and ineffective corrective actions, contributing to both acute and chronic safety risks. Multi-tier projects are particularly susceptible to such risks due to the distributed nature of accountability, variable contractor safety maturity, and limited visibility into subcontractor operations (Karaosman *et al.*, 2017; Colicchia *et al.*, 2019). Addressing these challenges requires a governance framework that integrates oversight mechanisms, decision pathways, and accountability structures across all contracting levels.

A governance-oriented perspective positions oversight, accountability, and strategic alignment as primary levers for improving contractor safety performance. By clarifying decision authority, defining roles and responsibilities, and implementing structured monitoring and feedback mechanisms, governance can shape contractor behavior proactively rather than reactively. Incentive structures, performance dashboards, and escalation pathways create visible and measurable expectations, encouraging contractors to adopt consistent safety practices and respond promptly to hazards. Governance mechanisms also facilitate integration and coordination across contractors, ensuring that safety objectives are aligned with organizational priorities, regulatory requirements, and project-specific risk profiles (Chakkol *et al.*, 2018; Li *et al.*, 2019). In this way, governance functions not merely as a compliance tool but as a strategic instrument for promoting proactive risk management and fostering a culture of safety accountability. The proposed governance-oriented conceptual model is based on several key assumptions. First, contractor safety performance is dynamic and context-dependent, influenced by both structural governance arrangements and operational conditions. Second, safety outcomes emerge from interactions among multiple actors, including project owners, contractors, and subcontractors, rather than solely from individual behavior or technical controls. Third, governance structures—including roles, decision authority, and oversight mechanisms—mediate and moderate contractor behavior, shaping adherence to safety standards and responsiveness to hazards. Fourth, the effectiveness of governance is contingent on data-driven monitoring, communication quality, and timely feedback, which enable continuous learning and adaptive risk management. Finally, the model assumes that integrating governance mechanisms with contractor-level safety management systems enhances both predictive risk control and organizational resilience, particularly in complex, multi-tier industrial projects (Matter and An, 2017; OSHOMEGIE *et al.*, 2019).

The rationale for adopting a governance-oriented conceptual model lies in the limitations of contractor-level safety systems and the risks introduced by gaps and misalignment in multi-contract projects. By emphasizing oversight, accountability, and strategic alignment, governance serves as a critical lever for shaping contractor behavior, promoting proactive hazard mitigation, and enhancing overall safety performance (Rosenberg, 2017; Boateng *et al.*, 2019). Grounded in the assumptions of dynamic, interactive, and context-sensitive risk management, the model provides a framework for integrating governance mechanisms with operational safety practices, offering both theoretical insight and practical guidance for improving contractor safety outcomes in complex industrial project environments.

2.4. Conceptual Model Overview

The governance-oriented conceptual model for contractor safety performance in multi-contract industrial projects provides a structured framework for understanding and managing the complex interactions that influence safety outcomes. At its core, the model integrates governance mechanisms, operational controls, and contractor behaviors within a multi-tier project ecosystem, emphasizing how oversight, accountability, and feedback processes collectively shape safety performance. The high-level architecture, grounded in systems thinking and organizational theory, is designed to capture the interdependencies among project owners, prime contractors, subcontractors, and frontline workers, providing a comprehensive perspective on proactive safety management in complex industrial environments.

The model is organized around three interrelated layers: governance inputs, operational mechanisms, and safety outcomes. Governance inputs include the structural, procedural, and contractual elements that define roles, responsibilities, decision authority, and accountability across contractors and subcontractors (Sarhan *et al.*, 2017; Muller, 2017). Operational mechanisms encompass the tools, processes, and practices through which governance is enacted, including risk assessment protocols, monitoring systems, communication pathways, and escalation procedures. Safety outcomes represent the perceptual, behavioral, and performance-based measures of contractor safety, capturing both leading indicators such as near-miss reporting, hazard observation, and training participation and lagging indicators, such as injuries, incidents, and property damage (Olamide and Badmus, 2019; OSHOMEGIE *et al.*, 2019). This layered architecture provides a clear logical flow from governance design to observed performance, ensuring that oversight mechanisms are linked to measurable safety results.

The model employs an inputs–mechanisms–outcomes (IMO) logic, which articulates how governance structures translate into tangible safety performance improvements. Inputs, including role clarity, contractual obligations, and data reporting requirements, define the enabling environment for safe operations. Mechanisms operationalize these inputs through monitoring, feedback, and intervention processes, ensuring that hazards are identified, corrective actions are taken, and learning is institutionalized. Outcomes reflect the effectiveness of governance, measured through contractor compliance, proactive risk mitigation behaviors, and improvements in both safety culture and operational reliability. This IMO structure underscores the causal pathways through which governance influences contractor behavior, providing a framework for empirical testing, performance evaluation, and continuous improvement.

The model incorporates multiple governance layers to reflect the hierarchical and lateral relationships inherent in multi-contract projects. Vertical governance spans project owners, primary contractors, and subcontractors, providing oversight and accountability across tiers. Horizontal governance connects peer contractors, interdisciplinary teams, and functional departments, facilitating coordination, information sharing, and harmonization of safety practices (Fedorowicz *et al.*, 2018; Baldini *et al.*, 2019).

Feedback loops operate at both the vertical and horizontal levels, enabling timely hazard reporting, verification of corrective actions, and learning from near-misses or incidents. These loops are reinforced through management dashboards, safety audits, performance reviews, and communication protocols, which allow leaders to monitor implementation fidelity, detect weak signals, and adjust governance strategies in response to evolving project conditions.

The model also emphasizes dynamic interaction between governance layers and contractor behavior, recognizing that safety outcomes are emergent properties of the system rather than simply the sum of individual actions. By integrating monitoring, feedback, and continuous learning into governance structures, the model supports a proactive, adaptive, and resilient approach to contractor safety management.

The governance-oriented conceptual model provides a holistic, multi-layered framework for understanding and improving contractor safety performance in complex multi-contract industrial projects. Its high-level architecture, built on inputs–mechanisms–outcomes logic, links structural governance elements to operational mechanisms and measurable safety outcomes. The inclusion of vertical and horizontal governance layers, coupled with continuous feedback loops, ensures that oversight is both comprehensive and adaptive, facilitating timely hazard identification, corrective action, and learning. By conceptualizing contractor safety performance as an emergent outcome of structured governance processes, the model offers a theoretically grounded and practically applicable framework that can guide project owners, safety managers, and policymakers in designing robust, integrated, and effective contractor safety management systems across complex project ecosystems (Bankole *et al.*, 2019; Ayanbode *et al.*, 2019).

2.5. Governance Structures Influencing Contractor Safety

In multi-contract industrial projects, contractor safety performance is heavily influenced by the governance structures established at multiple organizational levels. Effective governance provides the frameworks, oversight mechanisms, and decision pathways necessary to align contractor behavior with project safety objectives. Governance operates strategically at the owner/client level, programmatically across projects, and operationally at site level, creating a layered system of accountability and oversight (Hampton *et al.*, 2018; Stapleton *et al.*, 2018). Understanding how these governance structures function and interact is critical to improving contractor safety outcomes, mitigating risks, and fostering a proactive safety culture in complex project environments.

At the highest level, strategic governance is primarily the responsibility of project owners or clients, who establish the overarching safety leadership, vision, and policy framework for the project. This includes defining safety goals, performance expectations, and accountability standards that cascade through the project hierarchy. Safety requirements are embedded in procurement processes and contractual arrangements, ensuring that selected contractors comply with minimum safety standards and demonstrate the capacity for proactive risk management. Prequalification and contractor selection criteria serve as a critical control, as they evaluate

contractors based on safety management systems, historical performance, organizational culture, and risk mitigation capabilities. Strategic governance also encompasses monitoring mechanisms for adherence to contractual safety obligations, providing the foundation for consistent oversight across multiple contractors and project phases. By setting clear expectations and formalizing accountability structures at the strategic level, owners influence contractor behavior and establish the tone for safety culture throughout the project ecosystem (Olamide and Badmus, 2018; Nwafor *et al.*, 2019).

At the program and project levels, governance focuses on integrating contractor activities, managing interfaces, and ensuring operational alignment. Multi-contract projects often involve numerous parallel workstreams with overlapping responsibilities; integrated safety governance bodies and committees are established to facilitate coordination, resolve conflicts, and standardize safety practices across contractors. These structures address interface risks, ensuring that hazards arising from interdependent tasks or shared workspaces are identified, communicated, and mitigated proactively. Program-level governance also ensures alignment between project controls and contractor safety systems, promoting consistency in reporting, monitoring, and intervention. Coordination mechanisms, such as joint safety meetings, cross-contractor audits, and integrated risk registers, help prevent gaps in oversight while fostering collaboration and shared accountability. Effective program governance thus translates strategic safety objectives into actionable operational plans, bridging the gap between owner-level expectations and contractor-level execution (Jackson and Rahman, 2017; Maynard *et al.*, 2019).

Operational governance occurs at the site and frontline level, where the day-to-day application of rules, procedures, and oversight mechanisms determines actual contractor safety performance. Site-level supervision ensures the consistency of safety rules, work permits, and standard operating procedures across contractors and subcontractors, addressing variability in compliance and skill levels. Delegation of authority and escalation pathways clarifies who is responsible for decision-making when hazards arise, ensuring timely and effective interventions. Operational governance mechanisms include daily safety briefings, toolbox talks, inspections, and monitoring of near-misses, which reinforce safety expectations, identify emerging risks, and provide immediate corrective feedback (Warmerdam *et al.*, 2017; Hare *et al.*, 2017). By providing clear oversight and structured accountability at the operational level, these governance structures translate higher-level policies into concrete behaviors, supporting both compliance and proactive risk mitigation among contractors.

The effectiveness of contractor safety management depends on the integration of strategic, program, and operational governance. Strategic directives establish priorities and contractual obligations, program-level governance ensures coordination and interface management, and operational governance enforces standards on the ground. Feedback loops across these layers enable continuous monitoring, learning, and improvement, allowing lessons from incidents, near-misses, and audits to inform adjustments in policies, project procedures, and site-level practices. When properly aligned, governance structures provide a cohesive and multi-dimensional system that shapes contractor behavior, fosters accountability, and reinforces a culture of safety across

complex, multi-tier project ecosystems (Camilleri, 2017; Healy, 2019).

Governance structures at strategic, program, and operational levels collectively determine contractor safety performance in multi-contract industrial projects. Strategic governance establishes leadership, policy, and selection criteria that set expectations and allocate accountability. Program and project governance integrates contractor activities, manages interfaces, and aligns project-level controls, mitigating systemic risks. Operational governance ensures site-level consistency, supervision, and rapid escalation, translating policies into action. When effectively coordinated, these governance layers create a structured, integrated, and adaptive system that enables contractors to operate safely, supports proactive risk mitigation, and promotes a resilient safety culture (Ayanbode *et al.*, 2019). By conceptualizing contractor safety through a governance lens, project owners, managers, and regulators gain a framework for systematic oversight, performance improvement, and alignment across multiple contracting tiers, ensuring safer and more reliable project delivery in complex industrial environments.

2.6. Governance Processes and Mechanisms

In multi-contract industrial projects, governance processes and mechanisms play a pivotal role in shaping contractor safety performance. While governance structures define roles, responsibilities, and authority, governance processes operationalize these structures, providing the tools, protocols, and interactions through which oversight is exercised, accountability is enforced, and continuous improvement is facilitated (Marquardt, 2017; Kourula *et al.*, 2019). A governance-oriented approach emphasizes three key categories of mechanisms contractual and commercial, assurance and oversight, and engagement and capability-building which collectively create a robust framework for influencing contractor behavior and improving safety outcomes.

Contractual arrangements serve as one of the primary levers through which project owners influence contractor safety behavior. Safety performance clauses embedded in contracts define minimum standards, expected outcomes, and key performance indicators (KPIs), creating measurable expectations for contractor operations. These clauses typically include requirements for hazard reporting, near-miss documentation, training participation, and compliance with safety procedures. Beyond compliance, contracts often integrate performance-based incentives and penalties, aligning commercial interests with safety objectives. Incentives can include financial rewards, recognition programs, or eligibility for future work, encouraging contractors to adopt proactive risk management practices (Latimer, 2018; Keizer *et al.*, 2019). Conversely, penalties for safety violations or repeated non-compliance reinforce accountability. By aligning commercial objectives with safety goals, contractual and commercial mechanisms ensure that contractors view safety as an integral component of operational performance rather than a secondary or peripheral concern.

Assurance and oversight mechanisms provide the structural and procedural framework for monitoring, verification, and evaluation of contractor safety performance. Traditional approaches, such as audits and inspections, remain critical, providing independent verification that safety procedures are implemented correctly and consistently. However, effective

governance increasingly incorporates leading indicators and data-driven safety analytics, including near-miss reporting, hazard observation trends, and workforce engagement metrics. These tools allow project owners and managers to identify emerging risks, interface hazards, and systemic weaknesses before they result in incidents. Transparency and reporting requirements further strengthen oversight by ensuring that performance data is visible across governance layers, supporting timely decision-making, escalation, and remedial actions (Meijer *et al.*, 2018; Ingrams, 2018). Collectively, assurance mechanisms enhance trust, accountability, and predictive risk management, reinforcing the link between governance structures and contractor behavior.

Effective governance extends beyond monitoring to actively engaging contractors and building their capacity for safe operations. Joint safety planning sessions and collaborative risk assessments enable contractors, subcontractors, and project owners to co-develop mitigation strategies, ensuring alignment across interfaces and work packages. Structured contractor training and competency development programs reinforce technical skills, hazard awareness, and adherence to standardized procedures, particularly for transient or multi-tiered workforces. Collaborative learning initiatives, such as workshops, best-practice sharing, and cross-contractor benchmarking, foster continuous improvement, organizational learning, and culture reinforcement, enabling contractors to internalize safety expectations and enhance performance. Engagement and capability-building mechanisms thus operationalize governance as a shared responsibility, empowering contractors to contribute actively to hazard identification, risk mitigation, and proactive safety management (Lappi *et al.*, 2018; Al-Marri *et al.*, 2019).

The effectiveness of governance processes depends on their integration across contractual, assurance, and engagement dimensions. Contracts establish the formal expectations and incentives; assurance mechanisms verify compliance, monitor trends, and detect emerging risks; and engagement processes build capability, trust, and culture among contractors. Feedback loops link these mechanisms, enabling information from audits, safety analytics, and operational experience to inform contract enforcement, continuous improvement initiatives, and risk mitigation planning. This integrated approach ensures that governance is dynamic, adaptive, and aligned with both strategic safety objectives and operational realities.

Governance processes and mechanisms provide the practical levers through which contractor safety performance is influenced in multi-contract industrial projects. Contractual and commercial mechanisms establish accountability, align incentives, and formalize performance expectations. Assurance and oversight mechanisms provide verification, predictive risk management, and transparency across governance layers. Engagement and capability-building mechanisms foster collaborative learning, skill development, and proactive hazard management. By integrating these processes, project owners and managers create a cohesive governance system that drives consistent, resilient, and proactive contractor safety performance. The interplay of these mechanisms ensures that governance is not merely formalistic but functions as a strategic and operational enabler of safe, reliable, and high-performing multi-contract project delivery (Paswan *et al.*, 2017; Pahl-Wostl, 2019).

2.7. Mediating and Moderating Factors

In multi-contract industrial projects, contractor safety performance is influenced not only by governance structures and processes but also by mediating and moderating factors that shape how governance interventions translate into actual outcomes. Recognizing these factors is essential for understanding why similar governance mechanisms may yield different results across contractors, project phases, and operational contexts. These factors can broadly be categorized into contractor characteristics and project contextual factors, both of which interact dynamically with governance inputs to determine the effectiveness of safety interventions.

Contractor-specific attributes play a critical mediating role in determining how governance processes influence safety performance. Safety maturity and organizational capability are fundamental determinants. Contractors with mature safety management systems, established reporting protocols, and a culture of proactive risk management are better able to interpret, internalize, and operationalize governance directives, translating them into effective site-level safety behaviors. Conversely, contractors with limited safety experience, fragmented procedures, or weak organizational structures may struggle to implement oversight requirements, diminishing the impact of governance mechanisms (McDermott and Hayes, 2018; Orozco, 2019).

Workforce composition and turnover further moderate the relationship between governance interventions and safety outcomes. Multi-tier contractors often employ a mix of skilled, semi-skilled, and transient workers. High turnover rates, particularly among subcontracted labor, create challenges for consistent training, supervision, and reinforcement of safety expectations. Governance processes, such as performance monitoring or hazard reporting protocols, may be less effective when workforce continuity is low, requiring additional engagement and capability-building interventions to maintain compliance.

Prior safety performance history also serves as a mediator. Contractors with a track record of strong safety performance are more likely to adopt and sustain proactive practices in response to governance directives, whereas contractors with repeated safety violations may require stricter oversight, incentives, and corrective interventions to achieve comparable outcomes. Historical performance informs risk profiling, enabling governance bodies to tailor monitoring intensity, escalation protocols, and engagement strategies according to contractor reliability and responsiveness (Bilau *et al.*, 2018; Chapman, 2019).

Project-level contextual factors moderate the effectiveness of governance interventions and can either amplify or constrain their impact. The project phase is a primary determinant. During construction, risks are often high due to concurrent heavy-lift operations, multiple work fronts, and interface complexity, requiring intensive governance oversight and real-time intervention. In contrast, commissioning or operational phases may involve fewer contractors but higher process-specific hazards, emphasizing specialized monitoring and contractor competence.

Schedule pressure and resource constraints further shape the responsiveness of contractors to governance mechanisms. Tight project schedules, constrained staffing, or limited equipment availability can lead to shortcuts, procedural deviations, or deferred hazard mitigation, even under robust governance structures (Menchacatorre, 2017; Moosa, 2018).

Project owners must therefore integrate governance with realistic planning, resource allocation, and contingency mechanisms to prevent contextual pressures from undermining safety objectives.

Cultural and regulatory environments act as moderating influences as well. Projects operating across regions or countries may encounter diverse regulatory requirements, labor practices, and safety norms, requiring governance frameworks to be flexible and context-sensitive. Contractor adherence is influenced by both formal regulations and local safety culture, including attitudes toward compliance, risk perception, and hierarchical authority. Effective governance mechanisms must therefore be adapted to account for cultural expectations, language differences, and regulatory variations, ensuring consistency in safety performance across heterogeneous environments (Flynn *et al.*, 2018; Liarpoulos *et al.*, 2019).

Mediating and moderating factors function both independently and interactively, shaping the pathway from governance inputs to contractor safety outcomes. Contractor characteristics mediate how effectively oversight, contractual incentives, and engagement mechanisms are operationalized, while project contextual factors moderate the strength and direction of these relationships, creating variability in observed safety performance. For example, a highly mature contractor operating under low schedule pressure may achieve excellent safety outcomes even with moderate oversight, whereas a less experienced contractor facing resource constraints may require intensive governance, monitoring, and engagement to achieve similar results.

Mediating and moderating factors provide critical insight into the contingent nature of contractor safety performance in multi-contract industrial projects. Contractor characteristics including safety maturity, workforce composition, and prior performance mediate how governance mechanisms are implemented and internalized. Project contextual factors—such as project phase, schedule pressure, and cultural or regulatory environments—moderate the effectiveness of these interventions, influencing the intensity, adaptability, and outcomes of safety governance. Recognizing and integrating these factors into a governance-oriented conceptual model enhances its predictive capability, contextual sensitivity, and practical relevance, enabling project owners, safety managers, and policymakers to design tailored, adaptive, and resilient governance strategies that optimize contractor safety performance across complex, multi-tier industrial project ecosystems.

2.8. Safety Performance Outcomes

Safety performance outcomes in multi-contract industrial projects represent the tangible and intangible results of governance, management practices, and contractor engagement. These outcomes can be analyzed across three interconnected dimensions: direct safety outcomes, behavioral and cultural outcomes, and system-level outcomes. Each dimension captures distinct aspects of contractor safety performance while collectively reflecting the effectiveness of governance-oriented interventions, operational oversight, and workforce engagement. Understanding these outcomes is critical for evaluating the impact of governance mechanisms, informing continuous improvement, and enhancing overall project safety and resilience.

Direct safety outcomes are the most observable and

measurable indicators of contractor safety performance. These include reductions in injuries, incidents, and property damage, which serve as lagging indicators of system effectiveness. Governance processes, such as safety performance clauses, monitoring dashboards, and inspection protocols, aim to prevent accidents before they occur, thereby lowering the frequency and severity of adverse events. Another critical direct outcome is the enhancement of near-miss and hazard reporting rates. Near-misses, which capture events with potential for harm but no actual injury, provide valuable leading indicators of risk. Improvements in near-miss reporting signal increased vigilance, awareness, and proactive engagement among contractors, reflecting the operationalization of governance directives (Williams *et al.*, 2017; Zhou *et al.*, 2019). By tracking these metrics, project owners and safety managers can quantitatively assess the impact of governance structures, contractual incentives, and operational controls on immediate safety performance.

Behavioral and cultural outcomes reflect the human and organizational dimensions of safety performance, which are essential for sustaining long-term improvements. Compliance with safety rules and procedures is a fundamental behavioral outcome, ensuring that contractors adhere to established operational protocols. Beyond compliance, discretionary safety behaviors—such as peer-to-peer intervention, proactive hazard identification, and voluntary participation in safety initiatives—demonstrate internalization of safety responsibility and engagement. Cultural outcomes include trust in management, accountability, and shared ownership of safety across organizational boundaries. When governance mechanisms are effectively implemented, contractors perceive leadership commitment, receive timely feedback, and observe consistent enforcement of safety expectations. This fosters a psychologically safe environment, encouraging workers to report hazards, share knowledge, and engage in collaborative risk mitigation. Behavioral and cultural improvements are particularly critical in multi-contract projects, where diverse organizations and transient workforces require alignment of attitudes, perceptions, and motivations to reduce variability in safety practices.

System-level outcomes capture the broader organizational and project-wide effects of governance-oriented safety management. Multi-contract projects are interface-intensive, with overlapping work fronts, shared resources, and multiple contractors operating concurrently. Effective governance reduces interface-related incidents by clarifying roles, responsibilities, and escalation pathways, ensuring that hazards arising from handoffs or concurrent activities are proactively managed. Additionally, system-level outcomes include improvements in predictability and resilience of project delivery. By embedding safety performance as a core project metric, governance mechanisms reduce variability in operations caused by accidents, regulatory non-compliance, or workforce disruptions. Enhanced predictability facilitates efficient scheduling, resource allocation, and risk planning, while resilience reflects the system's capacity to anticipate, absorb, and adapt to emerging hazards, ensuring continuity and reliability of project execution.

Direct, behavioral, and system-level outcomes are interconnected and mutually reinforcing. For example, improvements in near-miss reporting (direct outcome) provide data that informs operational adjustments, enhancing discretionary safety behaviors (behavioral outcome) and

reducing interface-related incidents (system-level outcome). Similarly, enhanced trust and accountability within contractor teams strengthen engagement in hazard identification and reporting, feeding back into governance mechanisms to continuously refine oversight and intervention strategies (Lingard and Wakefield, 2019; Van Ooijen *et al.*, 2019). This integration underscores the multi-dimensional nature of safety performance, highlighting that governance effectiveness is reflected not only in incident statistics but also in cultural, behavioral, and systemic improvements.

Safety performance outcomes in multi-contract industrial projects encompass direct reductions in injuries and incidents, improvements in reporting behaviors, enhancements in compliance and discretionary safety practices, and broader system-level resilience. Governance-oriented mechanisms, including contractual clauses, assurance processes, and engagement initiatives, influence these outcomes through structured oversight, alignment of incentives, and continuous feedback. Evaluating performance across these dimensions provides a comprehensive understanding of contractor safety effectiveness, offering both practical insights for project management and theoretical contributions to governance-based safety frameworks. By integrating these outcome measures, project owners and safety professionals can optimize contractor behavior, foster a proactive safety culture, and enhance the predictability and reliability of complex project delivery.

2.9. Research Implications and Future Directions

The governance-oriented conceptual model for contractor safety performance in multi-contract industrial projects provides a structured framework for understanding how governance structures, processes, and mechanisms influence safety outcomes. While the model synthesizes theoretical perspectives from safety governance, principal-agent theory, and socio-technical systems, its practical and academic relevance depends on empirical validation and continuous refinement. Accordingly, the research implications and future directions span empirical testing, comparative analyses, and integration with emerging digital platforms, offering avenues for advancing both knowledge and practice in contractor safety management.

A primary research implication is the need for rigorous empirical testing of the relationships proposed in the conceptual model. While theoretical arguments suggest that governance structures and processes such as contractual clauses, oversight mechanisms, and engagement practices positively influence contractor safety outcomes, quantitative and qualitative validation is required to establish causal links. Empirical studies can employ multi-level modeling, structural equation modeling, or mixed-method approaches to assess how governance interventions impact direct safety outcomes, behavioral and cultural indicators, and system-level resilience (Tognazzo *et al.*, 2017; Eastwood *et al.*, 2019). For example, testing the effects of safety performance clauses and KPIs on incident reduction or near-miss reporting rates would provide evidence for the effectiveness of contractual governance mechanisms. Similarly, evaluating the mediating role of leadership visibility, communication quality, and feedback processes can clarify the mechanisms through which governance translates into tangible outcomes. Such empirical studies would inform both theory and

practice, enabling project owners to prioritize governance interventions that demonstrably improve safety performance. Multi-contract projects vary widely in terms of scale, complexity, sectoral hazards, workforce composition, and regulatory contexts. Therefore, comparative research across industries and project types is critical to understand the generalizability and contextual sensitivity of the governance-oriented model. Comparative studies can examine sectors such as oil and gas, energy infrastructure, construction, and manufacturing to identify sector-specific governance challenges and best practices. Cross-project analyses within the same industry can reveal how project size, contractor hierarchies, interface intensity, or schedule pressures moderate the effectiveness of governance interventions. Additionally, examining differences between national regulatory environments or cultural contexts can provide insights into how governance processes must be adapted for effective implementation. Comparative research will help refine the model, highlighting contingent factors and boundary conditions that influence contractor safety performance, and will generate actionable guidance for practitioners operating in diverse project ecosystems.

Emerging digital technologies offer novel opportunities to operationalize and enhance governance mechanisms in multi-contract projects. Integration with digital governance and safety platforms such as cloud-based reporting systems, real-time analytics dashboards, IoT-enabled monitoring, and predictive safety algorithms can increase visibility, accountability, and responsiveness across contractor hierarchies (Atobatele *et al.*, 2019; Nwaimo *et al.*, 2019). For example, digital dashboards can track contractor adherence to safety KPIs, monitor near-miss and hazard data in real time, and provide automated alerts for escalation thresholds. Such platforms can also facilitate cross-contractor collaboration, knowledge sharing, and lessons learned, strengthening system-level outcomes and reinforcing safety culture. Future research should explore the effectiveness, adoption barriers, and implementation strategies of digital tools in multi-contract governance, examining how technology augments traditional oversight, enhances predictive capabilities, and supports evidence-based decision-making.

In addition to empirical testing and digital integration, research can explore the interaction between governance mechanisms and contractor behavioral factors, such as trust, safety maturity, and workforce engagement. Longitudinal studies can examine the sustainability of governance interventions over time, particularly in projects with high contractor turnover or extended lifecycles. Further, cross-disciplinary research linking safety governance with organizational learning, resilience engineering, and risk management frameworks can provide a holistic understanding of how governance supports proactive, adaptive, and resilient safety performance.

The governance-oriented conceptual model provides a theoretical and practical framework for improving contractor safety performance, but its full potential depends on empirical validation, contextual comparison, and digital integration. Future research should focus on testing governance-performance relationships, conducting comparative analyses across industries and project types, and leveraging digital platforms to enhance oversight, accountability, and predictive safety management. By advancing these research directions, scholars and

practitioners can generate evidence-based strategies to optimize governance, strengthen contractor engagement, and ensure safer, more reliable delivery of complex, multi-contract industrial projects.

3. Conclusion

The governance-oriented conceptual model for contractor safety performance in multi-contract industrial projects provides a comprehensive framework for understanding how governance structures, processes, and mechanisms influence safety outcomes. The model integrates strategic, program, and operational governance layers, emphasizing contractual, assurance, and engagement mechanisms that collectively shape contractor behavior. It highlights the role of mediating and moderating factors, such as contractor characteristics, workforce composition, project phase, and contextual constraints, in determining the effectiveness of governance interventions. By linking governance inputs to direct safety outcomes, behavioral and cultural improvements, and system-level resilience, the model offers a multi-dimensional perspective on contractor safety performance.

The model contributes to the literature by addressing gaps in both contractor safety management and project governance research. It moves beyond traditional compliance- and contractor-centric approaches, framing safety as an emergent property of a structured, multi-tier governance system. The integration of socio-technical and systems perspectives, along with feedback loops and continuous improvement mechanisms, provides a theoretical basis for proactive and adaptive safety management. The model also extends prior research on principal-agent relationships and multi-tier oversight, demonstrating how contractual obligations, monitoring, and capability-building collectively influence safety outcomes across complex project ecosystems.

From a strategic standpoint, the governance-oriented model underscores that effective management of contractor safety performance is not solely a procedural issue but a central component of project success. Governance provides the mechanisms to align commercial objectives with safety expectations, ensure accountability across multiple contractor tiers, and foster a culture of shared responsibility. By emphasizing structured oversight, transparency, and capability development, the model highlights the importance of governance in reducing incidents, enhancing workforce engagement, and improving predictability and resilience in project delivery. Ultimately, this conceptual framework serves as a practical and theoretical guide for project owners, safety managers, and policymakers seeking to optimize contractor safety performance in multi-contract industrial projects, supporting safer, more reliable, and more efficient project execution.

References

1. Agrafiotis I, Creese S, Goldsmith M, Nurse JRC, Upton D. The relative effectiveness of widely used risk controls and the real value of compliance. Oxford: Department of Computer Science, University of Oxford; 2017. (CS-RR-17-01). Available from: https://www.cs.ox.ac.uk/files/8869/The_Relative_Effectiveness_of_widely_used_Risk_Controls_and_the_Real_Value_of_Compliance.pdf
2. Ahmed KS, Odejebi OD. Resource allocation model for energy-efficient virtual machine placement in data centers. IRE Journals. 2018;2(3):1-10.

3. Al-Marri M, Pinnington AH, Karatas-Ozkan M, Nicolopoulou K. The management of corporate social responsibility through projects: a more economically developed country perspective. *Bus Strategy Dev.* 2019;2(4):358-371.
4. Anichukwueze CC, Osuji VC, Oguntegbe EE. Global marketing law and consumer protection challenges: a strategic framework for multinational compliance. *IRE Journals.* 2019;3(6):325-333.
5. Atobatele OK, Hungbo AQ, Adeyemi CHRISTIANA. Digital health technologies and real-time surveillance systems: transforming public health emergency preparedness through data-driven decision making. *IRE Journals.* 2019;3(9):417-421.
6. Aven T, Ylönen M. A risk interpretation of sociotechnical safety perspectives. *Reliab Eng Syst Saf.* 2018;175:13-18.
7. Ayanbode N, Cadet E, Etim ED, Essien IA, Ajayi JO. Deep learning approaches for malware detection in large-scale networks. *IRE Journals.* 2019;3(1):483-502.
8. Badmus O, Olamide AL. Data-driven framework for predicting subsurface contamination pathways in complex remediation projects. *Iconic Res Eng J.* 2018;2(5):312-318.
9. Badmus O, Olamide AL. Advanced hydrological modeling approach for assessing climate-induced watershed vulnerability trends. *IRE Journals.* 2019;3(5):388-400.
10. Badri A, Boudreau-Trudel B, Souissi AS. Occupational health and safety in the industry 4.0 era: a cause for major concern? *Saf Sci.* 2018;109:403-411.
11. Baldini G, Barboni M, Bono F, Delipetrev B, Duch Brown N, Fernandez Macias E, *et al.* Digital transformation in transport, construction, energy, government and public administration. Luxembourg: Publications Office of the European Union; 2019. (JRC Science for Policy Report; JRC116179). DOI: 10.2760/689200.
12. Bankole FA, Dako OF, Onalaja TA, Nwachukwu PS, Lateefat T. AI-driven fraud detection enhancing financial auditing efficiency and ensuring improved organizational governance integrity. *Iconic Res Eng J.* 2019;2(11):556-577.
13. Bayeroju OF, Sanusi AN, Queen ZAMATHULA, Nwokediegwu SIKHAKHANE. Bio-based materials for construction: a global review of sustainable infrastructure practices. *J Front Multidiscip Res.* 2019;1(1):45-56.
14. Bilau AA, Witt E, Lill I. Practice framework for the management of post-disaster housing reconstruction programmes. *Sustainability.* 2018;10(11):3929.
15. Boateng F, Owusu-Manu DG, Adesi M, Parn E, Edwards DJ. Aligning strategic objectives to corporate governance objectives in construction professional service firms. *J Constr Proj Manag Innov.* 2019;9(1):1-18.
16. Bolici F, Castelli A, Hinna A. How blockchain reinforces transparency and accountability in PA's new governance models. In: *The social issue in contemporary society: relations between companies, public administrations and people.* Hershey, PA: IGI Global; 2019.
17. Camilleri MA. Corporate sustainability, social responsibility and environmental management: an introduction to theory and practice with case studies. Cham: Springer; 2017. DOI: 10.1007/978-3-319-46849-5.
18. Chakkol M, Selviaridis K, Finne M. The governance of collaboration in complex projects. *Int J Oper Prod Manag.* 2018;38(4):997-1019.
19. Chapman R. *The rules of project risk management: implementation guidelines for major projects.* 2nd ed. Abingdon: Routledge; 2019.
20. Colicchia C, Creazza A, Menachof DA. Managing cyber and information risks in supply chains: insights from an exploratory analysis. *Supply Chain Manag.* 2019;24(2):215-240.
21. Dainoff MJ. A sociotechnical approach to occupational safety. *Work.* 2017;56(3):359-370.
22. Dako OF, Okafor CM, Farounbi BO, Onyelucheya OP. Detecting financial statement irregularities: hybrid Benford-outlier-process-mining anomaly detection architecture. *IRE Journals.* 2019;3(5):312-327.
23. Eastwood JG, Kemp LA, Garg P, Tyler I, De Souza DE. A critical realist translational social epidemiology protocol for concretising and contextualising a "theory of neighbourhood context, stress, depression, and the developmental origins of health and disease (DOHaD)", Sydney Australia. *Int J Integr Care.* 2019;19(3):8.
24. Ekechi AT. Framework for lifecycle management and recycling of spent lithium-ion battery components. *Int J Multidiscip Res Growth Eval.* 2019;4(6):1271-1290. DOI: 10.54660/IJMRGE.2023.4.6.1271-1290.
25. Erigha ED, Obuse E, Ayanbode N, Cadet E, Etim ED. Machine learning-driven user behavior analytics for insider threat detection. *IRE Journals.* 2019;2(11):535-544.
26. Fedorowicz J, Sawyer S, Tomasino A. Governance configurations for inter-organizational coordination: a study of public safety networks. *J Inf Technol.* 2018;33(4):326-344.
27. Flynn MA, Castellanos E, Flores-Andrade A. Safety across cultures: understanding the challenges. *Prof Saf.* 2018;63(1):28-32.
28. Ford JL. Revisiting high-reliability organizing: obstacles to safety and resilience. *Corp Commun.* 2018;23(2):197-211.
29. Hampton S, Neal JG, Ramirez LA, Talkington DR. Task 10: research an alternative instructional design model. 2018.
30. Hare B, Cameron I, Lawani K. The development of a worker engagement maturity model for the improvement of occupational health and safety in construction. 2017.
31. Harvey EJ, Waterson P, Dainty AR. Applying HRO and resilience engineering to construction: barriers and opportunities. *Saf Sci.* 2019;117:523-533.
32. Healy M. Belonging, social cohesion and fundamental British values. *Br J Educ Stud.* 2019;67(4):423-438.
33. Ingrams A. Transparency for results: testing a model of performance management in open government initiatives. *Int J Public Adm.* 2018;41(13):1033-1046.
34. Jackson GW, Rahman SS. Security governance, management and strategic alignment via capabilities. In: *2017 International Conference on Computational Science and Computational Intelligence (CSCI); 2017 Dec; Las Vegas, NV. Piscataway, NJ: IEEE; 2017. p. 44-49.*
35. Karaosman H, Brun A, Morales-Alonso G. *Vogue or*

- vague: sustainability performance appraisal in luxury fashion supply chains. In: Gardetti MA, Muthu SS, editors. *Sustainable management of luxury*. Singapore: Springer; 2017. p. 301-330.
36. Keizer J, Beerlage-de Jong N, Braakman-Jansen A, al Naiemi N, ter Riet R, van Gemert-Pijnen JE. Antimicrobial Resistance Safety Stewardship (AMSS): empowering healthcare workers through quality management. In: *International Forum on Quality & Safety in Healthcare: People Make Change*; 2019 Mar. p. 177.
 37. Kontogiannis T, Leva MC, Balfe N. Total safety management: principles, processes and methods. *Saf Sci*. 2017;100:128-142.
 38. Kourula A, Moon J, Salles-Djelic ML, Wickert C. New roles of government in the governance of business conduct: implications for management and organizational research. *Organ Stud*. 2019;40(8):1101-1123.
 39. Lappi T, Karvonen T, Lwakatare LE, Aaltonen K, Kuvaja P. Toward an improved understanding of agile project governance: a systematic literature review. *Proj Manag J*. 2018;49(6):39-63.
 40. Latimer K. Momentum: a report on the 2017 Vizient Clinical Connections Summit. *Am J Med Qual*. 2018;33(1_suppl):4S-36S.
 41. Li Y, Han Y, Luo M, Zhang Y. Impact of megaproject governance on project performance: dynamic governance of the Nanning transportation hub in China. *J Manag Eng*. 2019;35(3):05019002.
 42. Liaropoulos A, Sapountzaki K, Nivolianitou Z. Adopting risk governance in the offshore oil industry and in diverse cultural and geopolitical context: North Sea vs Eastern Mediterranean countries. *Saf Sci*. 2019;120:471-483.
 43. Lingard H, Wakefield R. *Integrating work health and safety into construction project management*. Hoboken, NJ: John Wiley & Sons; 2019.
 44. Livorsi DJ, Goedken CC, Sauder M, Vander Weg MW, Perencevich EN, Reisinger HS. Evaluation of barriers to audit-and-feedback programs that used direct observation of hand hygiene compliance: a qualitative study. *JAMA Netw Open*. 2018;1(6):e183344.
 45. Lofquist EA, Dyson PK, Trønnes SN. Mind the gap: a qualitative approach to assessing why different sub-cultures within high-risk industries interpret safety rule gaps in different ways. *Saf Sci*. 2017;92:241-256.
 46. Maggetti M, Papadopoulos Y. The principal-agent framework and independent regulatory agencies. *Polit Stud Rev*. 2018;16(3):172-183.
 47. Marquardt J. Conceptualizing power in multi-level climate governance. *J Clean Prod*. 2017;154:167-175.
 48. Matter DIRS, An E. Stock returns sensitivity to interest rate changes. *J Finance Econ*. 2017;12(4):112-130.
 49. Maucec M, Gami S. Application of automated machine learning for multi-variate prediction of well production. In: *SPE Middle East Oil and Gas Show and Conference*; 2019 Mar. SPE; 2019. p. D032S069R003.
 50. Maynard S, Onibere M, Ahmad A. Defining the strategic role of the chief information security officer. *Pac Asia J Assoc Inf Syst*. 2018;10(3):3.
 51. McDermott V, Hayes J. Risk shifting and disorganization in multi-tier contracting chains: the implications for public safety. *Saf Sci*. 2018;106:263-272.
 52. Meijer A, 't Hart P, Worthy B. Assessing government transparency: an interpretive framework. *Adm Soc*. 2018;50(4):501-526.
 53. Menchacatorre Maza I. *Project bulk materials management guide: for The Case Company's Co-owner in Finland*. 2017.
 54. Michael ON, Ogunsola OE. Determinants of access to agribusiness finance and their influence on enterprise growth in rural communities. *Iconic Res Eng J*. 2019;2(12):533-548.
 55. Moosa M. Development of a model for determining factors affecting safety performance in the Saudi Arabian construction industry using structural equation modelling (SEM). 2018.
 56. Muller R. *Project governance*. Abingdon: Routledge; 2017. (Fundamentals of Project Management series).
 57. Nævestad TO, Hesjevoll IS, Phillips RO. How can we improve safety culture in transport organizations? A review of interventions, effects and influencing factors. *Transp Res Part F Traffic Psychol Behav*. 2018;54:28-46.
 58. Nwafor MI, Stephen G, Uduokhai DO, Aransi AN. Socioeconomic determinants influencing the affordability and sustainability of urban housing in Nigeria. *Iconic Res Eng J*. 2018;2(3):154-169.
 59. Nwafor MI, Uduokhai DO, Ifechukwu GO, Stephen D, Aransi AN. Developing an analytical framework for enhancing efficiency in public infrastructure delivery systems. *Iconic Res Eng J*. 2019;2(11):657-670.
 60. Nwafor MI, Uduokhai DO, Ifechukwu GO, Stephen D, Aransi AN. Quantitative evaluation of locally sourced building materials for sustainable low-income housing projects. *Iconic Res Eng J*. 2019;3(4):568-582.
 61. Nwaimo CS, Oluoha OM, Oyedokun OYE. Big data analytics: technologies, applications, and future prospects. *Iconic Res Eng J*. 2019;2(11):411-419.
 62. Odejebi OD, Ahmed KS. Performance evaluation model for multi-tenant Microsoft 365 deployments under high concurrency. *IRE Journals*. 2018;1(11):92-107.
 63. Odejebi OD, Hamed NI, Ahmed KS. Approximation complexity model for cloud-based database optimization problems. *IRE Journals*. 2019;2(9):1-10.
 64. Ogunsola OE, Oshomegie MJ, Ibrahim AK. Conceptual model for assessing political risks in cross-border investments. *Iconic Res Eng J*. 2019;3(4):482-493.
 65. Oguntegbe EE, Farounbi BO, Okafor CM. Conceptual model for innovative debt structuring to enhance midmarket corporate growth stability. *IRE Journals*. 2019;2(12):451-463.
 66. Okeke OT, Ugwu-Oju UM, Nwankwo CO. Advances in operating system integration improving productivity in business environments. *IRE Journals*. 2019;2(9):432-441.
 67. Okeke OT, Ugwu-Oju UM, Nwankwo CO. Conceptual model improving troubleshooting performance in enterprise information technology support. *IRE Journals*. 2019;3(1):614-622.
 68. Olamide AL, Badmus O. Spatially explicit risk modeling framework for tracking subsurface contaminant migration in data-limited remediation sites. *IRE Journals*. 2018;2(6):178-189.
 69. Olamide AL, Badmus O. Climate-responsive groundwater vulnerability assessment model integrating

- hydrological variability and land-use change. *IRE Journals*. 2019;3(6):449-460.
70. Orozco D. A systems theory of compliance law. *U Pa J Bus Law*. 2019;22:244.
 71. Oshomegie MJ. The spill over effects of staff strike action on micro, small and medium scale businesses in Nigeria: a case study of the University of Ibadan and Ibadan Polytechnic [dissertation]. Ibadan: University of Ibadan; 2018.
 72. Oshomegie MJ, Ibrahim AK, Ogunsola OE. Conceptual model for assessing political risks in cross-border investments. 2019.
 73. Oshomegie MJ, Ogunsola OE, Olajumoke B. Comprehensive review of quantitative frameworks for optimizing fiscal policy response to global shocks. *Evaluation*. 2019;11:12.
 74. Pahl-Wostl C. The role of governance modes and meta-governance in the transformation towards sustainable water governance. *Environ Sci Policy*. 2019;91:6-16.
 75. Paswan AK, Hirunyawipada T, Iyer P. Opportunism, governance structure and relational norms: an interactive perspective. *J Bus Res*. 2017;77:131-139.
 76. Pilkienė M, Alonderienė R, Chmieliauskas A, Šimkonis S, Müller R. The governance of horizontal leadership in projects. *Int J Proj Manag*. 2018;36(7):913-924.
 77. Powell SG, Baker KR. *Business analytics: the art of modeling with spreadsheets*. 6th ed. Hoboken, NJ: John Wiley & Sons; 2019.
 78. Reiman T, Pietikäinen E. Patient safety indicators as tools for proactive safety management and safety culture improvement. In: *Patient safety culture*. Boca Raton, FL: CRC Press; 2018. p. 183-204.
 79. Rosenberg J. More than a question of agency: privatized project implementation, accountabilities, and global environmental governance. *Rev Policy Res*. 2017;34(1):10-30.
 80. Santa R, Borrero S, Ferrer M, Gherissi D. Fostering a healthcare sector quality and safety culture. *Int J Health Care Qual Assur*. 2018;31(7):796-809.
 81. Sarhan S, Pasquire C, Manu E, King A. Contractual governance as a source of institutionalised waste in construction: a review, implications, and road map for future research directions. *Int J Manag Proj Bus*. 2017;10(3):550-577.
 82. Schuh G, Anderl R, Gausemeier J, ten Hompel M, Wahlster W. *Industrie 4.0 maturity index. Managing the digital transformation of companies*. 2017;61.
 83. Seyi-Lande OB, Arowogbadamu AAG, Oziri ST. A comprehensive framework for high-value analytical integration to optimize network resource allocation and strategic growth. *Iconic Res Eng J*. 2018;1(11):76-91.
 84. Seyi-Lande OB, Oziri ST, Arowogbadamu AAG. Leveraging business intelligence as a catalyst for strategic decision-making in emerging telecommunications markets. *Iconic Res Eng J*. 2018;2(3):92-105.
 85. Seyi-Lande OB, Oziri ST, Arowogbadamu AAG. Pricing strategy and consumer behavior interactions: analytical insights from emerging economy telecommunications sectors. *Iconic Res Eng J*. 2019;2(9):326-340.
 86. Stapleton B, Feldman B, Engel A. *Transforming LA's urban landscape-SoCal Edge final report*. Los Angeles, CA: Los Angeles Cleantech Incubator (LACI); 2018. (No. DOE-LACI-7065).
 87. Tognazzo A, Gubitta P, Gerli F. Fostering performance through leaders' behavioral competencies: an Italian multi-level mixed-method study. *Int J Organ Anal*. 2017;25(2):295-311.
 88. Troisi R, Alfano G. Towns as safety organizational fields: an institutional framework in times of emergency. *Sustainability*. 2019;11(24):7025.
 89. Ugwu-Oju UM, Okeke OT, Nwankwo CO. Advances in cybersecurity protection for sensitive business digital infrastructure. *IRE Journals*. 2018;1(11):127-135.
 90. Ugwu-Oju UM, Okeke OT, Nwankwo CO. Conceptual model improving encryption strategies for organizational information protection. *IRE Journals*. 2018;2(2):139-147.
 91. Ugwu-Oju UM, Okeke OT, Nwankwo CO. Conceptual model improving digital workflows within organizational information technology operations. *IRE Journals*. 2018;2(5):294-302.
 92. Ugwu-Oju UM, Okeke OT, Nwankwo CO. Review of network protocol stability techniques for enterprise information systems. *IRE Journals*. 2018;1(8):196-204.
 93. Uusikylä P. Endeavour to find evidence. The role evaluation in the complex systems of governance. 2019.
 94. Van Ooijen C, Ubaldi B, Welby B. *A data-driven public sector: enabling the strategic use of data for productive, inclusive and trustworthy governance*. 2019.
 95. Warmerdam A, Newnam S, Sheppard D, Griffin M, Stevenson M. *Workplace road safety risk management: an investigation into Australian practices*. *Accid Anal Prev*. 2017;98:64-73.
 96. Williams TA, Gruber DA, Sutcliffe KM, Shepherd DA, Zhao EY. Organizational response to adversity: fusing crisis management and resilience research streams. *Acad Manag Ann*. 2017;11(2):733-769.
 97. Yang D, Li M. Evolutionary approaches and the construction of technology-driven regulations. *Emerg Mark Finance Trade*. 2018;54(14):3256-3271.
 98. Yeboah BK, Enow OF. Conceptual framework for reliability-centered maintenance programs in electricity distribution utilities. *Iconic Res Eng J*. 2018;2(3):140-153.
 99. Yorio PL, Edwards J, Hoeneveld D. Safety culture across cultures. *Saf Sci*. 2019;120:402-410.
 100. Zhou Z, Li C, Mi C, Qian L. Exploring the potential use of near-miss information to improve construction safety performance. *Sustainability*. 2019;11(5):1264.