The Cost of Compliance: Evaluating Safety and Health Regulations in Kenya's Construction Industry

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Abstract

The construction industry makes a significant contribution to Kenya's economic growth by boosting employment, infrastructure, and GDP. Despite the critical importance of managing cost, quality, and time for project success, persistent safety and health issues highlight ongoing failures. Notwithstanding its importance, the cost of safety and health compliance remains under researched. This paper examines the impact of the cost of safety and health compliance in Kenya's construction sector, filling a gap in the existing literature. Grounded in Systems, Principal-Agent, Public Choice, and Regulatory Capture theories, it employs a pragmatism paradigm and a mixed-methods approach. A sample of 210 safety officers and site supervisors in Nairobi were randomly selected, achieving a 78% response rate. A linear regression analysis assessed the influence of compliance costs on safety and health practices in the Nairobi construction sector, revealing that compliance costs account for 66.9% of the variance ($\eta^2 = 0.669$, $\beta = 0.818$, $\rho < .001$), indicating a significant impact. This study recommends integrating safety and health costs into contract documents such as Bills of Quantities to improve budgeting transparency and regulatory adherence. The inclusion of standardised safety and health line items, such as the procurement of safety equipment and PPE, statutory costs, and the engagement of safety officers, are proposed to enhance the safety culture at worksites. These measures aim to optimise risk mitigation and resource allocation, providing actionable insights for Kenyan policymakers and industry stakeholders.

Keywords: Compliance Cost, Safety and Health Regulations, Projects, Construction Industry E-Learning, Individual Factors, Effective Adoption

Introduction

The global construction industry is growing by USD 0.3 trillion annually (1 USD = 128 Ksh) (Turner & Townsend, 2018). Cost, quality, and time remain the three primary drivers of successful projects (Phaobunjong, 2002). The construction sector is grappling with persistent safety and health (S&H) challenges. Construction workers face multifaceted hazards ranging from environmental exposures and task-specific dangers to incidental risks from adjacent operations (Purohit et al., 2018). These risks contribute to frequent accidents and illnesses, resulting in considerable downtime (Kiconco et al., 2019) and substantial financial burdens like compensation claims, insurance premiums, litigation expenses, and productivity losses (Wilson & Koehn, 2000). The complexity of safety and health management in this high-risk industry (Boadu et al., 2020) highlights the urgent need to balance operational efficiency with worker protection to achieve zero accidents on construction sites (ILO, 2006).

Cost competitiveness remains the dominant factor in construction procurement, especially in private-sector projects (Azeem et al., 2020). While this cost-driven approach may yield short-term savings, it often leads to budget misallocation, particularly when safety and health (S&H) costs are not explicitly itemised within the Bills of Quantity or assigned realistic cost within the contract documents (Akawi et al., 2017). Without clear S&H cost allocations, contractors either underbid to win tenders or cut corners during execution, undermining compliance and project performance (Ibid). Construction contracts that lack clearly defined S&H cost provisions often lead to possible construction failures and unsafe site practices, ultimately increasing the total project cost (Oswald et al., 2020). Similarly, unrealistically low bids that overlook safety and health obligations result in budget overruns, delays, and contractual disputes (Gbahabo & Samuel, 2017). The reliance on low-cost subcontractors, vendors or suppliers also heightens these risks, as they often lack the necessary resources for proper S&H compliance (Oswald et al., 2020). These eventually expose the Main Contractor to legal liabilities, penalties, and corrective expenses, thus affecting the overall project costs.

Conversely, empirical evidence suggests that proactive investments in safety and health (S&H) measures enhance project value by minimising accident-related disruptions (Kibe, 2016). Existing research also provides insights into the recommended optimal S&H investment percentage for the different construction works (Bachar et al., 2025). Bachar et al. (2025) further suggest that 3–5% of project cost should be allocated to S&H practices within small and medium-sized enterprises (SMEs) projects by contractors registered typically within NCA 6 to NCA 8. Similarly, Shohet et al. (2018) and Marleno et al. (2019) propose approximately 1–1.7% of total project costs as the average S&H expenditure for any construction project. Yang et al. (2021) reported that safety compliance costs in South Korea account for approximately 1.86% of total project costs, emphasising the critical need for dedicated funding to support safety and health compliance and preventive measures. In Kenya, it is common for main contractors to exclude explicit S&H cost allocations and instead provide lump-sum estimates typically under the preliminaries section of the Bills of Quantities. This practice is attributable to the lack of established standardised S&H provisions within contract documents. Supporting this observation, while financial constraints are a legitimate concern, consistently prioritising cost over safety can negatively impact contractors' overall performance and project outcomes (Oswald et al., 2020).

Safety and Health Regulations in Kenya's Construction Sector

While global urban systems demonstrate progressive institutionalization of occupational safety standards (Oladejo, 2020), Kenya's rapidly urbanizing counties exhibit a distinct regulatory-performance paradox. This sector accounts for a significantly disproportionate 16% of total occupational fatalities despite employing approximately 7% of the total country workforce (Kemei, 2019; KNBS, 2021). This fatality rate surpasses those of other economic industries by 3.2 times, reflecting fundamental failure (Mutua et al., 2023). The existing statutory framework seems disconnected from the realities of construction ecologies, where informal labor markets and compressed project execution stages undermine safety and health (S&H) performance (Mitullah & Wachira, 2003).

The Occupational Safety and Health Act, 2007 (OSHA 2007) is the primary legislation for ensuring workplace safety and health in Kenya, applicable to all workplaces, including construction sites. The Work Injury Benefits Act (WIBA), 2007 provides compensation to workers for work-related injuries and diseases. The Building Code 2024, though primarily focused on construction standards and approvals, also includes elements related to safe design and site management. The Directorate of Occupational Safety and Health Services (DOSHS) under the Ministry of Labour enforces OSHA and oversees compliance. The National Construction Authority (NCA) regulates the construction industry, ensuring adherence to safety standards on construction sites. Despite this robust legal framework, enforcement faces challenges such as cost-cutting measures, where safety is often compromised to reduce expenses.

This study assesses the financial implications of safety and health (S&H) compliance in Kenya's construction sector, examining direct costs and indirect economic impacts. It explores the cost-benefit dynamics of adopting S&H protocols, mitigating health risks, and adhering to statutory requirements while evaluating the long-term returns on such investments. The research highlights contractors' recurrent underestimation of S&H budgetary allocations, attributable to insufficient regulatory frameworks and limited enforcement. Specifically, the study examines the statutory compliance costs and the financial consequences of safety-related incidents in construction projects and recommends strategies towards minimising on-site accidents in Kenya.

Theoretical Framework

Table 1 presents a summary of the theoretical frameworks utilized in this study.

Table 1: Summary of Theoretical Frameworks for the Study

No.	Theory	Description
1.	Systems Theory	Consistent with Rwelamila and Abdul-Aziz (2020), this study employs systems theory to identify the hierarchical structures and interdependencies within the construction industry, highlighting the expected safety and health (S&H) costs at every level and how they impact the overall project performance. It examines cost drivers and regulatory frameworks within broader systemic contexts, offering insights into their dynamic interactions.
2.	Principal-Agent theory (PAT)	PAT is a rational-choice framework that examines contractual relationships between two parties: the *principal* (delegates authority) and the *agent* (acts on the principal's behalf) (Braun & Guston, 2003). Cost-cutting measures, negligence, or lax enforcement, increase worker vulnerability (Mwaisaka, 2013). In some cases, workers who demand personal protective equipment (PPE) face retaliatory dismissal (Muema, 2016). There is a need for

		the regulator (agent) to act on behalf of the construction workers (principal) and ensure that the cost of S&H compliance is within the contract documents.
3.	Public Choice Theory of Regulation (PCT)	In Kenya's construction sector, policymaking frequently favors the interests of industry lobby groups who seem to have a voice as well as a budget to push their agenda. For instance, contractors hold representation on statutory boards, such as NCA, through influential associations like the KFMB, RACECA, and KABCEC. However, despite comprising the majority of the workforce, construction workers lack comparable representation in advocacy channels, resulting in unequal influence over regulatory and compliance decisions. To enhance S&H compliance, the government should enforce policy frameworks that channel funds to construction worker associations to advocate for their welfare and S&H compliance.
4.	Regulatory Capture Theory of Regulation	Regulations explicitly impose barriers to entry into a regulated market, such as licenses, permits, and compliance certificates, without which one may not legally operate in a market or industry (OECD, 2005). Incumbent construction firms may even receive legacy consideration from regulators, meaning that only new entrants are subject to specific regulations (Wirsching, 2018). By such an unfair market approach, many MSME contractors fail to provide basic safety infrastructure and PPE to their workers due to cost constraints. To address this, MSME contractors should receive incentives and waivers to enhance their competitiveness and encourage greater S&H compliance.

Literature Review

This part of the paper elucidates the existing and pertinent body of knowledge through a comprehensive review of the literature.

Costs Associated with Compliance with On-Site Safety and Health Regulations

The Occupational Safety and Health Act (OSHA, 2007) stipulates that construction workers must comply with safety regulations, participate in mandatory safety and health (S&H) training and adhere to on-site safety directives (Kibe, 2016). However, in Kenya, construction workers frequently encounter constrained bargaining power and substandard working conditions (Mitullah & Wachira, 2003). Their low literacy levels hinder their ability to understand and implement safety and health protocols, exposing them to unsafe and unhealthy conditions on-site (Boadu et al., 2020; Wilson & Koehn, 2000). OSHA (2007) delineates employer obligations, emphasizing the provision of a hazard-free workplace and requisite safety training (Kibuthu, 2016). Despite these mandates, some contractors ignore compliance, prioritizing project timelines over worker safety practices, a tendency exacerbated under accelerated construction schedules (Lingard & Rowlinson, 2004).

S&H Equipment & PPE

Studies indicate that 25-35% of accidents result from tools or equipment mishandling due to inadequate training (Cheng et al., 2020). Though Kenya's Employment Act (2007) mandates employers to provide workers with safety and health user instruction (ILO, 2006), significant gaps persist. Recommended S&H training, including on-site inductions, refresher courses, and toolbox talks, are crucial for hazard mitigation (Muema, 2016; Choudhry et al., 2008). However, many contractors neglect these initiatives, prioritising short-term savings over essential investments, leading to higher costs from preventable accidents and injuries. Although PPE does not eradicate workplace hazards, it reduces injury risks by isolating workers

from residual dangers (Munyua, 2017). Regulatory frameworks mandate contractors to supply suitable PPE to all construction personnel unless hazards have been eliminated through administrative, engineering, substitution or elimination controls, as underscored by the hazard hierarchy of control depicted in Figure 1 (Lawani et al., 2017; Lyon & Popov, 2019; NIOSH, 2021). PPE includes all equipment, such as weather-protective clothing, used by workers at the worksite to safeguard against health and safety risks (Ammad, 2021).

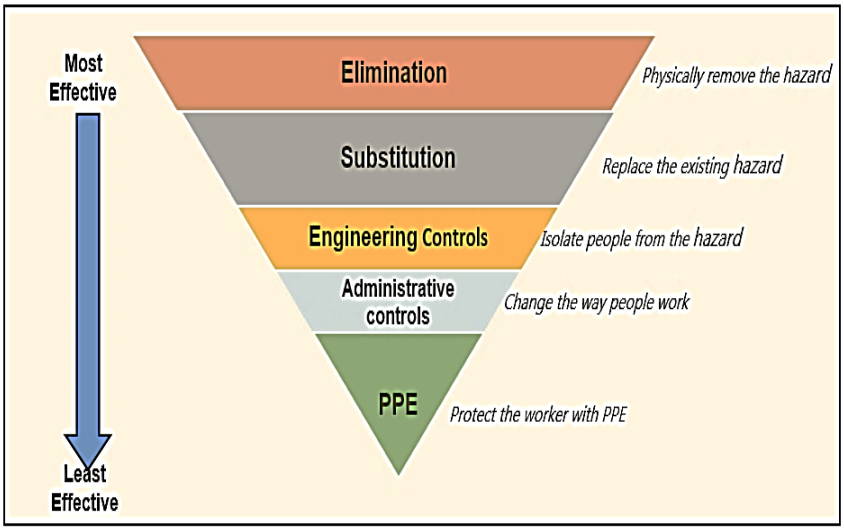

Figure 1: Hierarchy of Hazard Control

Source: Compiled by Author (2025) from NIOSH (2021) and Mansdorf (2019)

Kenya's Occupational Safety and Health Act (2007) mandates the provision of personal protective equipment (PPE) for all construction workers at an average cost of Ksh. 7,000 to 15,000 per worker, depending on hazard exposure and task complexity (Gurcanli et al., 2015). Effective PPE use requires ergonomic standards, regular maintenance, and proper training (Kolisi, 2015; Schaufelberger & Lin, 2013). Training programs, crucial for safety management (Hughes & Ferrett, 2015), demand significant investments, including facilitator fees and productivity losses due to downtime. This impact is notable in specialised training, like crane operation (Spellman, 2018). Basic training includes selecting hazard-specific PPE, proper usage, maintenance, and defect identification (Castro-Sánchez, 2021). However, many contractors fail to implement adequate training, leading to preventable work-site hazard exposures, underscoring the need for integrated training to improve safety and health practices in construction sites. Despite regulations, many Kenyan contractors fail to provide adequate PPE, shifting burdens to construction workers or offering limited equipment only on specific days, compromising worker protection and leading to additional costs, especially in the event of hazard exposure on site.

S&H Statutory Requirement

When budgeting for statutory compliance, it is essential to consider applicable laws and mandated regulatory requirements (Windapo, 2013). The costs charged by the various statutory entities are subject to change due to fluctuation, legislative tax and fiscal changes, exchange rates, and changes in associated government policies.

a) Directorate of Occupational Safety and Health Services (DOSHS)

The Occupational Safety and Health Act (2007) requires all workplaces to register with DOSHS at a fee of KES 3,000, along with a KES 2,000 levy and an annual renewal fee of KES 5,000 (DOSHS, 2023). However, only 0.7% of Kenya's estimated 1.7 million workplaces were registered, and 75% of these did not renew their certifications (OAG, 2016). According to OSHA (2007), equipment like cranes must be registered within the acquisition period, with a registration fee of KES 5,000, and are subject to a biannual inspection fee. With a 98.3% non-registration rate, systemic failures in enforcement or incentives are evident and need investigation. Kenya's construction safety regime mandates dual insurance through legislative and contractual means. The Work Injury Benefits Act (WIBA, 2007) requires a 0.91% payroll deduction to cover employment injuries and diseases, resulting in Kshs. 20,000-30,000 annually for a 10-construction worker team in Nairobi, with compensation capped at 96 months' earnings. Contractors All Risks (CAR) insurance provides asset protection at 1-3% of the project value, covering risks like fire, natural disasters, and criminal acts, as mandated by the Public Procurement and Asset Disposal Act (2015).

The literature reveals a disconnect between cost-saving strategies and the financial risks of non-compliance with the Work Injury Benefits Act (WIBA), which is common among contractors (Kihoro, 2020). Many mistakenly view avoiding insurance as a cost-saving measure, exposing them to liabilities when accidents occur with uninsured workers, resulting in direct compensation and legal costs (Mbatha, 2013). The absence of WIBA costs in procurement documents, especially in Bills of Quantities, allows contractors to bid lower by omitting insurance, thereby externalising risks (Zubaru, 2021). Over time, this practice increases project costs due to unexpected payouts and legal liabilities. This study advocates for procurement reforms that require explicit inclusion of WIBA costs, ensuring compliance, safeguarding construction workers, and enabling accurate project costing.

The Occupational Safety and Health Act (OSHA, 2007) requires all construction sites in Kenya to maintain a full-time safety officer on site as a regulatory mandate and contractual obligation. Industry's best practices recommend a minimum ratio of one safety officer and two safety supervisors per 100 workers to ensure adequate safety coverage (Li et al., 2015). The specific composition of safety personnel varies according to project scale and complexity López-Alonso et al., 2013). The effective deployment of these safety professionals is particularly crucial for high-risk construction projects in Kenya, where their presence can significantly mitigate worksite hazards. The cost structure for safety personnel is multifaceted, being principally determined by three key project dimensions: physical scale, inherent risk characteristics, and technical complexity, as codified in the Project Management Body of Knowledge (PMI, 2021).

In the Kenyan construction sector, safety officers are paid monthly remuneration ranging from Ksh 30,000 to Ksh 100,000 (approximately USD 234-781 at an exchange rate of 1 USD = 128 Ksh), with compensation levels reflecting individual qualifications, years of relevant experience, and specific role expectations. Notably, these personnel costs are typically absorbed within project preliminary expenses rather than being explicitly delineated in bills of quantities, reflecting common industry accounting practices for safety-related expenditures. The true costs of on-site S&H compliance including direct fees and indirect costs like safety personnel expenses, should be quantified. Since the required number of safety officers per 100 workers can be determined, this cost should be calculable for bid evaluation and explicitly integrated into project budgets, either akin to clerk of works costs or via competitive labour-rate pricing.

Regulatory frameworks, particularly Section 22 of Kenya's Occupational Safety and Health Act (2007), explicitly mandate the provision of adequate welfare facilities, recognizing their critical role in worker health and safety compliance (Tukesiga, 2022). Such facilities must include potable water supplies, sanitary conveniences, hygiene stations, changing accommodations, and designated rest areas, which are essential components for maintaining workforce welfare and meeting statutory obligations (Gupta et al., 2018). Cost analysis of these provisions must account for capital expenditures and recurrent operational outlays, with total financial commitments varying substantially based on project-specific parameters including geographical location, scale, timeline, and procurement method (Çelik et al., 2017; Gupta et al., 2018). Proper financial planning through the establishment of necessary safety items for these proposed projects is imperative, not only for regulatory adherence but also for enhancing workforce productivity through improved health outcomes and reduced incident rates. These items can be described and quantified based on the proposed projects, allowing bidders to quote and be evaluated accordingly.

Regulatory requirements under OSHA (2007), specifically regulation 95 stipulate that contractors must maintain fully equipped first-aid facilities on site, compliant with prescribed standards. Industry data indicates that a properly stocked, wall-mounted first-aid cabinet suitable for a standard workforce of 25 workers requires an investment of between Ksh 15,000 to Ksh 20,000 (approximately USD 117-156 at current exchange rates), with optimal placement within 20-30 meters of work areas to ensure accessibility. Contractors bear additional responsibility for maintaining emergency medical equipment and supplies, coupled with the requirement to employ trained first-aid personnel. The scale and complexity of these safety provisions are directly correlated with project dimensions, as larger or more hazardous sites necessitate more extensive safety infrastructure (Yang et al., 2021). The procurement and upkeep of safety equipment and facilities represent a significant cost component in construction projects, as established by Godschalk (2009). Systematic maintenance protocols serve a dual purpose: they ensure continuous operational readiness while minimizing equipment failure risks that frequently contribute to unplanned project disruptions (Kelly, 2006).

b) National Environment Management Authority (NEMA)

The Environmental Impact Assessment and Audit Regulations (2003) establish a standardized approval framework administered by the National Environment Management Authority (NEMA). This regulatory framework requires all construction projects, regardless of risk classification, to obtain an EIA license before commencement. The process typically takes a median duration of 30 days (NEMA, 2022 Annual Report). The fiscal burden of safety and health practice on-site is undertaken within a sliding-scale model, with basic EIA/EA license fees set at 0.1% of the total project cost. These fees have a minimum threshold of KES 10,000 (equivalent to USD 78.13 at an exchange rate of 1 USD = KES 128), with no defined upper limit (GoK, 2003).

Incorporating environmental impact assessment (EIA) compliance costs as a distinct line item during bidding enhances regulatory compliance and optimizes project budgets. Explicit budgeting of EIA costs during procurement significantly improves environmental compliance rates by 42% ($\rho<0.01$) and ensures accurate cost forecasting (Magerer, 2018). This strategy allows for competitive procurement of specialized environmental consulting services, provided cost estimations include statutory NEMA fees (0.1% of project value, minimum KES 10,000) and risk-adjusted contingencies for mitigation (5-7% of total EIA costs). Contractual integration strengthens compliance by setting clear performance metrics linked to NEMA

approval milestones and incorporating penalties for non-performance, fostering technical quality and cost efficiency (Hemed, 2019).

c) Nairobi City County

Nairobi City County (NCC) administers a construction permitting system aligning with Kenya's decentralised county governance structure (Wamuyu, 2017). The current regulatory framework mandates a fee structure of Kshs. 21,000 to Kshs. 30,000 per square meter of the proposed built-up area (approximately USD 164-234 at an exchange rate of 1 USD = Kshs. 128). These fees encompass multiple safety and health compliance components (NCC, 2023). The fee structure typically includes construction signboard and hoarding fees of between KES 15,000 and KES 30,000, depending on the location, plus monthly licensing fees of Kshs. 6,000 to Kshs. 10,000; mandatory construction site inspection fees of Kshs. 5,000; and certificate of occupancy fees of Kshs. 5,000. Upon permit issuance, NCC requires contractors to erect site signboards, schedule necessary inspections via the county's digital platform, comply with EMCA (1999) noise regulations, and adhere to the National Building Code (2024) material specifications. Contractors must maintain debris-free sites, provide approved PPE to workers, submit revised plans for county approval before design changes, employ certified construction site agents, and implement traffic management plans to minimize disruptions during material transport (ILO, 1995).

The systematic integration of NCC's safety and health (S&H) compliance costs into contractual documents offers an effective method for enhancing bidding precision and regulatory compliance. 38% of projects lack occupational certificates and thus tend to be non-compliant. Explicitly itemising these costs in tender documents demonstrates improved compliance. Consultants should be able to prepare technically compliant bids that adequately cover the 0.8-1.2% of project value typically needed for NCC fees in mid-rise developments. This cost allocation fosters enforceable contractual obligations, minimising safety cost-cutting during execution and establishing objective supervision benchmarks for compliance milestones, thus transforming S&H compliance into a proactively managed component.

d) National Construction Authority

Prior to initiating any construction works, contractors operating in Kenya must secure mandatory compliance certificate from the National Construction Authority (NCA). The certification process involves a financial levy of 0.5% of total contract value for projects exceeding Kshs. 5 million, though this requirement was suspended in 2017 following the government Executive Order. Despite this fiscal adjustment, contractors must display a standardized site signage detailing project, including contractor registration details, client, consultants and details of other statutory approvals. Strict enforcement of personal protective equipment (PPE) protocols for all site personnel, with particular emphasis on high-risk activities. Strategic placement of hazard information and cautionary signage conforming to S&H visual communication standards. Complete perimeter security through approved fencing or hoarding systems meeting specified height and stability requirements (NCA Regulation, 2014). Mandatory engagement of registered professional geotechnical engineer for excavations exceeding three (3) meters deep, requiring geotechnical assessments and shoring plans.

Construction sites as guided by the Building Code 2024, are typically fitted with comprehensive safety and health infrastructure, including safety netting, first aid stations, fire suppression systems, and welfare facilities, all designed to mitigate and respond to workplace incidents (ILO, 2022). Beyond initial

procurement costs, these provisions require systematic maintenance to ensure operational readiness and service life optimization (Brauer, 2022).

Prudent financial planning necessitates the incorporation of maintenance and replenishment expenditures into project budgets, as this practice facilitates optimal resource allocation, prevents cost overruns, and enhances overall financial predictability (Adugna, 2015). Contemporary research by Rastegari and Salonen (2015) emphasizes the importance of customized maintenance approaches that account for equipment-specific variables, including operational intensity and environmental exposure factors. The consequences of maintenance neglect are multifaceted, potentially compromising equipment performance and fundamental workplace safety standards (Zou et al., 2007). A well-maintained and replenished equipment inventory serves not merely as a safety precaution, but also as a tangible demonstration of organizational compliance and commitment to operational best practices (Adugna, 2015). Manufacturer-provided technical manuals constitute essential references in this regard, offering detailed safety protocols and preventive maintenance specifications that should inform all maintenance strategies. Empirical research by Thomas and Weiss (2021) quantifies this investment, demonstrating that annual maintenance costs typically range between 2-5% of total asset replacement value, a modest expenditure that yields disproportionate returns in accident prevention and operational reliability.

The exchange of critical information pertaining to safety, health, risks, and precautions among workers, supervisors, consultants, and employers is frequent on construction sites (Kines et al., 2010). Effective communication ensures comprehension of safety and health protocols, identification of hazards, and clarity of emergency procedures, thereby mitigating the risk of accidents and injuries (Zara et al., 2023). The key elements of safety and health communication on construction sites include safety inductions and training, signages and cautionary information, safety briefings and toolbox talks, incident reporting systems and emergency communication. Each S&H induction session incurs indirect costs, as it involves man-hours when construction workers are not actively engaged in work. It is possible to schedule one safety induction per month or every fortnight and thus it is possible to cost the amount needed per month and during the entire project.

Safety Communication

a) Information & Cautionary Signages

When hazards cannot be avoided or minimized, contractors must implement the appropriate risk hierarchy of controls and consider administrative methods, such as safety information or cautionary signages, to protect construction workers from injuries and incidents (Asumeng et al., 2015). Construction site signages plays a crucial role as a visual communication tool by conveying essential safety and health information, warning of potential hazards, and providing necessary instructions (Ibid). The safety signs employed on construction sites adhere to a standardized color scheme akin to the "*traffic light*" system. Meis and Kashima (2017) describe the color red to represent prohibition signage, indicating actions that are not permitted; yellow to signify a cautionary signage, alerting workers from potential hazards. Green is associated with safety instruction signage, representing positive actions or conveying safety guidelines whereas blue is utilized for mandatory instruction signage (Yang et al., 2012; Gambatese & Liu, 2018), that communicate obligatory actions, such as the requirement to "*wear a hard hat*." In addition to the color coding, certain basic shapes of the signages are used as standardized in a certain way. According to Kadiyali

(2017), discs or circles are utilized for prohibitions and instructions, triangles for warnings, while squares and rectangles are applied for emergency and informational signages.

The procurement of safety signage, although straightforward, incurs significant costs due to standardized requirements for color and the required reflectivity (Dewlaney & Hallowell, 2012). In Kenya some signages are displayed in foreign languages that many workers do not understand. This issue is particularly prevalent among foreign contractors, who inadvertently create linguistic barriers. Therefore, emphasizing standardized signage is essential to enhance safety communication on construction sites. Every site should have a minimum budget requirement for installation of safety signages which should be factored at the beginning of the project and staggered throughout the life cycle of the project.

a) Emergency Exist & Fire Assembly Point

To facilitate efficient evacuation during emergencies, construction sites must be equipped with a minimum of two exit routes strategically located as far apart as possible (Abdelgawad, & Abdulhai, 2009). This arrangement significantly diminishes the risk of exits being obstructed by a single source of fire or smoke. Furthermore, it is essential to maintain separate pathways, clearly marked crossing zones and well-defined emergency evacuation routes to ensure the safe movement of pedestrians and vehicular traffic on-site (Kubba, 2012). The visibility of fire exits and assembly area signage on construction sites is paramount for every undertaking (Hughes & Ferrett, 2009). Such signages are indispensable, as they guarantee that all individuals can swiftly and efficiently vacate the site, thereby reducing the likelihood of injuries during emergencies (Galea et al., 2019). Effective safety and health communication on construction sites are crucial for minimizing risks and ensuring that all workers are informed about the hazards and safety protocols in place to protect their health and well-being (Choudhry & Fang, 2008). These should be factored at the design stage of the stage so that the cost estimate is captured and consisted in a timely manner.

Summary of Compliance Costs on On-Site S&H Protocol

The costs associated with S&H compliance in construction are multifaceted, encompassing direct expenditures such as training programs, PPE procurement, statutory fees, and safety personnel salaries, as well as indirect investments in equipment, facilities, and communication initiatives (Okonkwo, 2019). While these components are well-documented, critical empirical gaps remain in understanding their cumulative impact on project outcomes. Traditional project success metrics of cost, quality, and schedule (Chan & Chan, 2004) are often studied in isolation from S&H performance, despite evidence that trade-offs between these factors can compromise safety outcomes (Kaplan & Cooper, 1998; Smallwood & Haupt, 2006). For instance, the relationship between S&H budget allocations and incident reduction lacks robust longitudinal data, particularly in cost-sensitive environments where contractors may deprioritize safety to meet competing demands. Table 2 below presents a detailed examination of the empirical gap, summarizing potential S&H percentage compliance costs across various construction sub-sectors, as noted by Marleno et al. (2019).

Table 2: Compliance Cost Percentage for S&H Activities Across Construction Sub-sectors

No.	OSH Details	Roads (%)	Bridge (%)	Dams (%)	Buildings (%)
1.	S&H Training & Induction	0.007	0.007	0.004	0.027
2.	Work Protective Equipment & PPE	0.092	0.092	0.054	0.168
3.	S&H Statutory Compliance	0.018	0.018	0.018	0.274
4.	S&H Officer(s) /Personnel	0.480	0.540	0.427	0.711
5.	Health & Welfare facilities / First Aid Equipment	0.036	0.036	0.021	0.131
6.	S&H Communication; Information & Cautionary Signages, PTW etc	0.023	0.023	0.008	0.034
7.	Insurance & licensing (*CAR, WIBA*)	0.184	0.189	0.756	0.363
Total (%)		0.840	0.905	1.290	1.708

Source: Compiled by Author (2025) from Marleno et al. (2019)

The costs associated with safety and health compliance vary across different sub-sectors within the construction industry, ranging from a minimum of 0.8% in road projects to a maximum of 1.7% in building projects (Marleno et al., 2019). This discrepancy is attributable to the complex structural designs and detailed work required in building projects as compared to road projects. Such complexity increases the probability of design and construction errors, consequently elevating S&H risk levels.

Methodology

While grounded in the pragmatism paradigm, this study adopted the mixed-methods framework by Creswell et al. (2011), as referenced in Legishion et al. (2024), to facilitate a multi-dimensional analysis of the central research questions. The study employed a combination of structured, unstructured, and observational surveys to record real-time occurrences within construction worksites. The dataset were systematically analyzed using SPSS Version 27, as guided by Ibem and Laryea (2017), allowing for the identification of trends. In agreement with the proceedings of Pansakun et al. (2024), this study employed a cross-sectional design for data collection within a constrained timeframe (Wang & Chen, 2020). Consistent with Young's (2015) findings, the study used questionnaires due to their ability to capture large volumes of data, ease of administration, and suitability for statistical analysis. Random sampling was applied due to its impartiality, procedural simplicity, and statistical robustness (Sharma et al., 2025).

Focusing on construction workers operating within Nairobi's construction environment, the study adhered to stringent ethical protocols to mitigate assessed potential risks beyond those inherent in routine day-to-day exposures. In alignment with Saunders et al. (2009), the study implemented robust protective measures by excluding vulnerable demographic groups to minimize ethical complexities. Uncoerced engagement was ensured by providing participants with explicit rights to withdraw, implementing systematic anonymity through the suppression of personal identifiers, and conducting a multi-stage briefing process detailing confidentiality safeguards in accordance with Crow et al. (2006) findings. Consistent with Legishion et al. (2024), the study targeted all 896 construction sites in Nairobi, as derived from an analysis of the NCA registry data as of December 2022.

As emphasized by Casteel and Bridier (2021), determining an appropriate sample size is critical for ensuring valid population-level inferences, a core objective of research methodology. In line with this

principle, this study applied Cochran's (1977) sampling formula, consistent with the framework outlined by Frankfort-Nachmias and Nachmias (2000). Specifically, for populations exceeding 10,000 units, the sample size (n_1) is determined using the standard normal distribution approximation as cited by Legishion et al. (2024), incorporating a 95% confidence level ($z = 1.96$; Afzal et al., 2024), an assumed proportion ($\rho = 0.5$ to maximise variance) with its complement ($q = 1-\rho$), and a predefined margin of error ($E = 0.05$). It follows Cochran's (1977) formula: $n_1 = (z^2\rho q)/E^2$. However, for finite populations ($N < 10,000$), the initial estimate requires adjustment via the finite population correction factor as alluded to by Legishion et al. (2024) to improve precision (Bartlett et al., 2001). The adjusted sample size (n) is derived using the following equation: $n = n_1/[1+((n_1-1)/N)]$. The finite population protocol was applied as follows:

$n_1 = (1.96^2 \times 0.5 \times 0.5)/0.05^2 = 384.16 \rightarrow 384$
$n = 384/[1+(383/896)] = 267.62 \rightarrow \underline{268}$

The study surveyed 268 construction sites, representing a 29.9% sampling fraction. This sample size ensures a 95% confidence level (Powell, 2024) with a ±5% margin of error, accounting for the finite population (Krejcie & Morgan, 1970). The approach meets statistical power requirements and practical feasibility (Fischer et al., 2022). A total of 210 questionnaires were returned out of the 268 distributed, yielding a 78% response rate, considered satisfactory for analysis.

Social Demographics

The study found that 80.5% of the workforce consisted of site supervisors, while 19.5% were safety officers, as shown in Table 3. This imbalance may be attributed to the prioritization of project timelines, cost, and quality standards over S&H compliance in many construction projects in developing countries (Ofori, 2012). Contrary, contractually, the clause on safety requirements stipulated under OSHA (2007), mandates the main contractor to appoint a safety officer physically stationed on-site at all times. This is also specified in the preliminary section of a typical Bills of Quantities within the various standard contract documents.

Table 3: Distribution of Respondents by Job Title

Job Title	Frequency (f)	Cumulative Frequency (c.f)	Percent (%)
Site Supervisors	169	169	80.5%
Safety Officers	41	210	19.5%
Total	210		100%

Source: Field Survey, 2023

The study discovered that in Kenya, site supervisors assume the majority, approximately 80%, of the S&H responsibilities. However, the law mandates all contractors to engage safety officers to oversee safety and health compliance at construction sites (OSHA, 2007). Mirroring Ahmed et al. (2022), the study found that 80.5% of respondents (169/210) were site supervisors, while the rest (41) were safety officers, indicating familiarity with on-site S&H practices. 67% (114) of these site supervisors performed the safety officer roles despite lacking formal S&H training, reflecting non-compliance and cost-cutting practices. There is a need to explicitly include S&H variables within the BOQs to improve on-site S&H management.

Regression Analysis

A linear regression analysis was conducted to evaluate the influence of Cost of Compliance on On-site S&H Regulation (Table 4). The R^2 value of 0.669 suggests that 66.9% of the variability in regulatory compliance is attributable to cost factors.

Table 4: Cost of Compliance and On-site S&H Regulation

Model Summary				
Model	**R**	**R Square (R^2)**	**Adjusted R Square**	**Standard Error of the Estimate**
1	.818[a]	.669	.668	2.20840
		a. Predictors: (Constant), Cost of Compliance		
		b. Dependent Variable: On-site S&H Regulation		

Source: Field Survey, 2023

The high R^2 value (0.669) in Table 4 indicates a strong model fit, confirming that *Cost of Compliance* is a statistically significant predictor of *On-site S&H Regulation*. This substantial explanatory power suggests that policies, interventions, and strategic decisions targeting compliance costs could impact S&H regulatory outcomes within construction sites.

Discussions

The study presents clear and compelling evidence that explicit consideration of S&H items in the BOQs will enhance the evaluation of contractors during the pre-construction stage based on competitively quoted rates, compliance and management of safety practices on construction sites. These results furnish crucial insights for policymakers and construction consultants, underscoring the dual benefits of compliance investments: satisfying regulatory mandates and markedly improving S&H standards. The finding alludes to the prioritisation of an adequate budget, highlighting the intersection of financial incentives and regulatory effectiveness. Through the incorporation of the cost of S&H compliance into policy frameworks, policymakers address the economic realities faced by contractors in compliance with OSHA (2007).

The study findings underscore the critical relationship between compliance costs and safety outcomes in Kenya's construction sector, presenting actionable insights for industry practitioners, policymakers, and researchers. For construction firms, the link demonstrated between financial investment and safety performance suggests that contractors should prioritise cost-effective S&H interventions that deliver measurable returns. Given the strong linear regression relationship observed ($\beta = 0.818$), contractors would benefit from developed BOQs with itemised S&H features for consideration within the project.

Through the adoption of evidence-based strategies that align S&H compliance requirements with economic realities within the different sub-sectors, Kenya's construction industry can make meaningful progress toward safer workplaces without imposing unsustainable burdens on contractors.

Conclusions

This study highlights the need for a fundamental rethinking of safety and health (S&H) compliance practices within Kenya's construction industry. Current approaches, which provide for S&H measures in the preliminary section of the contract documents, should evolve toward the integration of itemised S&H

consideration. Contractual frameworks should reinforce this perspective by embedding safety requirements and cost structures in bidding and execution documents. Doing so ensures that compliance is not only monitored but financially planned, reducing the risk of cost overruns and delays caused by safety violations or work stoppages. For construction stakeholders, this entails a proactive shift: treating safety investments not as regulatory burdens but as essential components of project success and organisational performance.

The study recommends that the stakeholders allocate dedicated budget lines for key safety interventions, including the procurement and maintenance of work protective equipment and personal protective equipment (PPE), acquiring safety personnel, statutory compliance, S&H Training and Induction, first aid and welfare facilities and S&H Communication. Integrating these costs within the project's baseline financial structure strengthens the foundation for robust safety management systems.

The study calls for the institutionalisation of safety budgeting, including integrating safety as a mandatory criterion in tender evaluations, explicitly incorporating safety line items in Bills of Quantities (BOQs), and defining allocations for critical S&H measures such as PPE. Construction consultants, particularly Quantity Surveyors and Cost Engineers, are encouraged to incorporate standardised S&H BOQ templates within the tender documentation. This practice will not only ensure transparency but also establish industry-wide norms that will prioritise safety from the outset.

To strengthen S&H compliance and oversight, the study proposes the development of a centralised regulatory database for monitoring the engagement and deployment of construction safety officers. This system should define minimum qualifications, set standardised compensation structures, and mandate the presence of at least one registered safety officer on every active construction site. Such institutional mechanisms would significantly enhance baseline safety outcomes and improve sector-wide accountability.

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No potential conflict of interest was reported by the authors.

References

Abdelgawad, H., & Abdulhai, B. (2009). Emergency evacuation planning as a network design problem: A critical review. *Transportation Letters, 1*(1), 41-58.

Adugna, N. T. (2015). *A study of causes of delay and cost overrun in office construction projects in the eThekwini Municipal Area, South Africa* [Doctoral dissertation].

Ahmed, S. M., Azhar, S., Saul, A. D., & Mahaffy, K. L. (Eds.). (2022). *Proceedings of the 12th International Conference on Construction in the 21st Century (CITC 12), Amman, Jordan*. Construction in the 21st Century (CITC).

Akawi, E. J., Musonda, I., & Ansary, N. (2017). *A conceptual model for pricing health & safety on construction projects*. Handle: https://hdl.handle.net/10210/244757

Ammad, S., Alaloul, W. S., Saad, S., Altaf, M., Alawag, A. M., & Ali, M. (2021). Building information modelling (BIM) and occupational safety in infrastructure projects. In *2021 International Conference on Data Analytics for Business and Industry (ICDABI)* (pp. 240-244). IEEE.

Asumeng, M., Asamani, L., Afful, J., & Agyemang, C. B. (2015). Occupational safety and health issues in Ghana: Strategies for improving employee safety and health at workplace. *International Journal of Business and Management Review, 3*(9), 60-79.

Azeem, M., Ullah, F., Thaheem, M. J., & Qayyum, S. (2020). Competitiveness in the construction industry: A contractor's perspective on barriers to improving the construction industry performance.

Bachar, R., Urlainis, A., Wang, K.-C., & Shohet, I. M. (2025). Optimal allocation of safety resources in small and medium construction enterprises. *Safety Science, 181*, 106680. https://doi.org/10.1016/j.ssci.2024.106680

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal, 19*, 43-50.

Boadu, E. F., Wang, C. C., & Sunindijo, R. Y. (2020). Characteristics of the construction industry in developing countries and its implications for health and safety: An exploratory study in Ghana. *International Journal of Environmental Research and Public Health, 17*(11), 4110. https://doi.org/10.3390/ijerph17114110

Brauer, R. L. (2022). *Safety and health for engineers* (3rd ed.). John Wiley & Sons.

Braun, D., & Guston, D. H. (2003). Principal-agent theory and research policy: An introduction. *Science and Public Policy, 30*(5), 302-308.

Bunni, N. G., & Bunni, L. B. (2022). *Risk and insurance in construction* (3rd ed.). Routledge. https://doi.org/10.1201/9781003222514

Casteel, A., & Bridier, N. L. (2021). Describing populations and samples in doctoral student research. *International Journal of Doctoral Studies, 16*(1).

Castro-Sánchez, E., Alexander, C. M., Atchison, C., Patel, D., Leung, W., Calamita, M. E., Meno Garcia, D., Cimpeanu, C., Mumbwatasai, J. M., Ramid, D., Doherty, K., Grewal, H. S., Otter, J. A., & Wells, E. M. (2021). Evaluation of a personal protective equipment support programme for staff during the COVID-19 pandemic in London. *Journal of Hospital Infection, 109*, 68–77. https://doi.org/10.1016/j.jhin.2020.12.004

Çelik, T., Kamali, S., & Arayici, Y. (2017). Social cost in construction projects. *Environmental Impact Assessment Review, 64*, 77-86. https://doi.org/10.1016/j.eiar.2017.03.001

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons. https://www.scirp.org/reference/ReferencesPapers?ReferenceID=1390266

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). *Best practices for mixed methods research in the health sciences*. National Institutes of Health.

Crow, G., Wiles, R., Heath, S., & Charles, V. (2006). Research ethics and data quality: The implications of informed consent. *International Journal of Social Research Methodology, 9*(2), 83-95.

Cheng, M., Gaamangwe, T., Erskine, J., Napke, E., Lehtiniemi, L., Moher, B., ... & Moonsoo, Y. (2020). A systems management framework for medical device safety and optimal outcomes. In *Clinical Engineering Handbook* (pp. 321-328). Academic Press.

Choudhry, R. M., Fang, D., & Rowlinson, S. (2008). Challenging and enforcing safety management in developing countries: A strategy. *International Journal of Construction Management, 8*(1), 87-101.

Dewlaney, K. S., & Hallowell, M. (2012). Prevention through design and construction safety management strategies for high performance sustainable building construction. *Construction Management and Economics, 30*(2), 165-177.

Fischer, S., Ali, N., Feneberg, A. C., Mewes, R., & Nater, U. M. (2022). Does childhood trauma impact daily psychobiological stress in somatic symptom disorder? An ambulatory assessment study. *Frontiers in Psychiatry, 13*, 954051.

Frankfort-Nachmias, C., & Nachmias, D. (2000). *Research methods in the social sciences* (6th ed.). Wadsworth.

Galea, E. R., Deere, S., Xie, H., Hulse, L., & Cooney, D. (2019). Construction site evacuation safety: Evacuation strategies for tall construction sites.

Gambatese, J. A., & Liu, D. (2018). *Student work safety guidelines in roadside applications and work zones: Safety guidelines for transportation researchers* (No. FHWA-OR-18-08). Oregon Dept. of Transportation.

Gbahabo, P., & Samuel, A. O. (2017). Effects of infrastructure project cost overruns and schedule delays in sub-Saharan Africa. In *11th International Conference on Social Sciences Helsinki* (pp. 20-21).

Godschalk, D. R., Rose, A., Mittler, E., Porter, K., & West, C. T. (2009). Estimating the value of foresight: Aggregate analysis of natural hazard mitigation benefits and costs. *Journal of Environmental Planning and Management, 52*(6), 739-756.

Government of Kenya. (2003). *Environmental Impact Assessment and Audit Regulations, 2003* (Legal Notice No. 101). Government Printer. https://www.nema.go.ke/images/Docs/Regulations/EIA_Audit_Regulations2003.pdf

Government of Kenya. (2007). *Employment Act, 2007* (No. 11 of 2007). Government Printer. https://www.kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/EmploymentAct2007.pdf

Government of Kenya. (2007). *Occupational Safety and Health Act, 2007* (No. 15 of 2007). Government Printer. https://www.kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/OccupationalSafetyandHealthAct2007.pdf

Government of Kenya. (2007). *Workers' Injury Benefits Act, 2007* (No. 13 of 2007). Government Printer. https://www.kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/WorkersInjuryBenefitsAct_No13of2007.pdf

Gupta, M., Hasan, A., Jain, A. K., & Jha, K. N. (2018). Site amenities and workers' welfare factors affecting workforce productivity in Indian construction projects. *Journal of Construction Engineering and Management, 144*(11), 04018101.

Gurcanli, G. E., Bilir, S., & Sevim, M. (2015). Activity based risk assessment and safety cost estimation for residential building construction projects. *Safety Science, 80*, 1-12.

Hemed Wengo, S. (2019). *Oil exploration and compliance with the Convention on Biological Diversity (CBD): A case study of the marine environment in Lake Turkana, Kenya* [Master's dissertation]. Kampala International University.

Hughes, P., & Ferrett, E. (2009). *Introduction to health and safety in construction* (3rd ed.). https://doi.org/10.1016/B978-1-85617-521-0.50024-9

Hughes, P., & Ferrett, E. (2015). *International health and safety at work: For the NEBOSH International General Certificate in Occupational Health and Safety* (3rd ed.). Routledge. https://doi.org/10.4324/9781315733012

Ibem, E. O., & Laryea, S. (2017). E-tendering in the South African construction industry. *International Journal of Construction Management, 17*(4), 310-328.

International Labour Organization. (2006). *Promotional Framework for Occupational Safety and Health Convention No. 187*. https://www.ilo.org/dyn/normlex/en/f?p=NORMLEX

International Labour Organization. (2001). *Guidelines on occupational safety and health management systems (ILO-OSH 2001)*. https://www.ilo.org/safework/info/instr/WCMS_107727/lang--en/index.htm

International Labour Organization. (2015). *Global trends on occupational accidents and diseases*. https://www.ilo.org/safework/events/safeday/WCMS_407576/lang--en/index.htm

International Labour Organization. (2022). *A safe and healthy working environment is a fundamental principle and right at work*. https://www.ilo.org/publications/safe-and-healthy-working-environment-fundamental-principle-and-right-work

International Labour Office. (1995). *Safety, health and welfare on construction sites: A training manual*. ISBN 92-2-109182-1

Kadiyali, L. R. (2017). *Highway engineering*. Khanna Publishing House.

Kelly, A. (2006). *Strategic maintenance planning* (Vol. 1). Elsevier.

Kibe, K. N. (2016). *Assessment of health and safety management on construction sites in Kenya: A case of construction projects in Nairobi County* [Master's thesis]. Jomo Kenyatta University of Agriculture and Technology.

Kibuthu, P. G. (2016). *Influence of planning of physical facilities on the provision of Quality Learning Environment in Secondary Schools in Narok North Sub-County, Kenya* [Master's dissertation]. Egerton University.

Kiconco, A., Ruhinda, N., Halage, A. A., Watya, S., Bazeyo, W., Ssempebwa, J. C., & Byonanebye, J. (2019). Determinants of occupational injuries among building construction workers in Kampala City, Uganda. *BMC Public Health, 19*, 1-11.

Kihoro, S. (2020). *Influence of safety compliance on performance of small and medium construction firms in Nairobi County* [Doctoral dissertation]. Strathmore University.

Kines, P., Andersen, L. P., Spangenberg, S., Mikkelsen, K. L., Dyreborg, J., & Zohar, D. (2010). Improving construction site safety through leader-based verbal safety communication. *Journal of Safety Research, 41*(5), 399-406.

Kisilu, P. M. (2018). *Prevalence of work-related musculoskeletal disorders among housing construction workers in Mombasa County, Kenya* [Master's dissertation]. JKUAT-COHES.

Kiura, C. (2021). *Revisiting Work Injury Benefits Framework for Kenya: A Case for Review of WIBA 2007* [Master's dissertation]. University of Nairobi.

Kolisi, B. (2015). *Ergonomic considerations for the design of women's functional protective wear for the local construction industry* [Doctoral dissertation]. Cape Peninsula University of Technology.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610. https://doi.org/10.1177/001316447003000308

Kubba, S. (2012). *Handbook of green building design and construction: LEED, BREEAM, and Green Globes*. Butterworth-Heinemann.

Lawani, K., Hare, B., & Cameron, I. (2017). Developing worker engagement maturity model for improving occupational safety and health in construction. In *Conference Proceedings: Joint CIB W099 and TG59 International Safety, Health, and People in Construction*.

Legishion, J. J., K'Akumu, O. A., & Wachira, I. N. (2024). Impact of institutional frameworks on safety and health in construction sites. *Africa Habitat Review, 19*(1), 2729-2741.

Legishion, J. J., Wachira, I. N., & K'Akumu, O. A. (2024). Attitudes of workers toward safety and health compliance in construction sites in Nairobi. *Africa Habitat Review, 19*(2), 2910-2927.

Li, H., Lu, M., Hsu, S. C., Gray, M., & Huang, T. (2015). Proactive behavior-based safety management for construction safety improvement. *Safety Science, 75*, 107-117.

Lingard, H., & Rowlinson, S. (2004). *Occupational health and safety in construction project management*. Routledge.

López-Alonso, M., Ibarrondo-Dávila, M. P., Rubio-Gámez, M. C., & Munoz, T. G. (2013). The impact of health and safety investment on construction company costs. *Safety Science, 60*, 151-159.

Lyon, B. K., & Popov, G. (2019). Risk treatment strategies: Harmonizing the hierarchy of controls and inherently safer design concepts. *Professional Safety, 64*(05), 34-43.

Magerer, V. K. (2018). *Risk management and implementation of capital projects in Nairobi City County, Kenya* [Master's dissertation]. Kenyatta University.

Marleno, R., Tjendani, H. T., & Bon, A. T. (2019). The cost of occupational safety and health (OSH) in construction project. In *Proceedings of the International Conference on Industrial Engineering and Operations Management Toronto, Canada* (pp. 23-25).

Mbatha, S. M. (2013). *Impact of safety and health audits on the working conditions in Nairobi Metropolis* [Master's dissertation].

Meis, J., & Kashima, Y. (2017). Signage as a tool for behavioral change: Direct and indirect routes to understanding the meaning of a sign. *PLoS ONE, 12*(8), e0182975.

Mitullah, W. V., & Wachira, I. N. (2003). *Informal labour in the construction industry in Kenya: A case study of Nairobi*. International Labour Organization.

Muema, L. M. (2016). *Evaluation of personal protective equipment utilization among construction workers in Mombasa County, Kenya* [Master's thesis]. Jomo Kenyatta University of Agriculture and Technology.

Munyua, K. M. (2017). *Influence of intrinsic motivation on job performance and organisational commitment among the employees: Case of k-Unity, Kiambu County, Kenya* [Master's dissertation]. University of Nairobi.

Mwaisaka, N. (2013). *Assessment of workers' health and safety at work place: A case study Wentworth Resources Ltd and OLAM in Mtwara Municipal* [Doctoral dissertation]. The Open University of Tanzania.

Nairobi City County. (2023). *Building control and regularisation initiatives*. https://www.nairobi.go.ke

National Construction Authority. (2014). *National Construction Authority Regulations, 2014* (Legal Notice No. 74). Government Printer. https://new.kenyalaw.org/akn/ke/act/ln/2014/74/eng@2017-11-24

National Construction Authority. (2024). *National Building Code 2024* (Legal Notice No. 47). Government Printer. https://new.kenyalaw.org/akn/ke/act/ln/2024/47/eng@2024-03-01

National Institute for Occupational Safety and Health (NIOSH). (2021). *Worker health chartbook, 2021* (NIOSH Publication No. 2021-110). https://www.cdc.gov/niosh/docs/2021-110/

OECD. (2005). *Guidelines for the quality and performance of regulation*. https://www.oecd.org/mena/governance/40501864.pdf

Ofori, G. (Ed.). (2012). *Contemporary issues in construction in developing countries* (1st ed.). Routledge. https://doi.org/10.4324/9780203847350

Oswald, D., Ahiaga-Dagbui, D. D., Sherratt, F., & Smith, S. D. (2020). An industry structured for unsafety? An exploration of the cost-safety conundrum in construction project delivery. *Safety Science, 122*, 104535.

Pansakun, N., Naksen, W., Boonchieng, W., Ong-artborirak, P., & Prapamontol, T. (2024). Environmental health literacy regarding fine particulate matter and related factors among village health

volunteers in upper northern Thailand. *Journal of Preventive Medicine and Public Health, 57*(2), 138–147. https://doi.org/10.3961/jpmph.23.434

Phaobunjong, K. (2002). *Parametric cost estimating model for conceptual cost estimating of building construction projects* [Doctoral dissertation]. The University of Texas at Austin.

Powell, K. (2024). *Analyzing the impact of STEM bins on fourth-grade student attendance in a Georgia elementary school: A quantitative causal comparative study* [Doctoral dissertation]. American College of Education.

Project Management Institute (PMI). (2021). *A guide to the project management body of knowledge (PMBOK Guide)* (7th ed.).

Purohit, D., Siddiqui, N., Nandan, A., & Yadav, B. (2018). Hazard identification and risk assessment in construction industry. *International Journal of Applied Engineering Research, 13*(10), 7639-7667.

Rastegari, A., & Salonen, A. (2015). Strategic maintenance management - Formulating maintenance strategy. *International Journal of Condition Monitoring and Diagnostic Engineering Management*.

Rwelamila, P. D., & Abdul-Aziz, A. R. (Eds.). (2020). *Improving the performance of construction industries for developing countries: Programmes, initiatives, achievements and challenges*.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students*. Pearson.

Schaufelberger, J., & Lin, K. Y. (2013). *Construction project safety* (Vol. 93). John Wiley & Sons.

Sharma, G. S., Singh, S. O., & Sinha, B. K. (2025). Simple random sampling and effective use of additional resources. *Calcutta Statistical Association Bulletin, 00080683241299484*.

Shohet, M., Luzi, M., & Tarshish, M. (2018). Optimal allocation of resources in construction safety: Analytical-empirical model. *Safety Science, 104*. https://doi.org/10.1016/j.ssci.2018.01.005

Spellman, F. R. (2018). *Safety engineering: Principles and practices* (3rd ed.). Rowman & Littlefield.

Thomas, D., & Weiss, B. (2021). Maintenance costs and advanced maintenance techniques in manufacturing machinery: Survey and analysis. *International Journal of Prognostics and Health Management, 12*(1).

Tukesiga, P. (2022). *Health and safety performance on construction sites in Rwanda* [Master's dissertation]. JKUAT-COHRED.

Turner & Townsend. (2018). *International construction market survey 2018*. http://www.turnerandtownsend.com/en/insights/international-construction-market-survey-2018/

Wamuyu, I. N. (2017). *Evaluation of building approval processes on construction project delivery (Time and Cost)-A study of Nairobi City County* [Master's dissertation]. University of Nairobi.

Wang, X., & Cheng, Z. (2020). Cross-sectional studies: Strengths, weaknesses, and recommendations. *Chest, 158*(1), S65-S71.

Were, E., Kiplagat, J., Kaguiri, E., Ayikukwei, R., & Naanyu, V. (2023). Institutional capacity to prevent and manage research misconduct: Perspectives from Kenyan research regulators. *Research Integrity and Peer Review, 8*(1), 8.

Wilson, J. M., & Koehn, E. E. (2000). Safety management: Problems encountered and recommended solutions. *Journal of Construction Engineering and Management, 126*(1), 77-79.

Windapo, A. O. (2013). Relationship between degree of risk, cost and level of compliance to occupational health and safety regulations in construction. *Australasian Journal of Construction Economics and Building, 13*(2), 67-82.

Wirsching, E. (2018). *The revolving door for political elites: Policymakers' professional background and financial regulation* (Working Paper No. 222). University of Mannheim.

Yang, H., Chew, D. A., Wu, W., Zhou, Z., & Li, Q. (2012). Design and implementation of an identification system in construction site safety for proactive accident prevention. *Accident Analysis & Prevention, 48*, 193-203.

Yang, K., Kim, K., & Go, S. (2021). Towards effective safety cost budgeting for apartment construction: A case study of occupational safety and health expenses in South Korea. *Sustainability, 13*(3), 1335.

Young, T. J. (2015). Questionnaires and surveys. *Research methods in intercultural communication: A practical guide*, 163-180.

Zara, J., Nordin, S. M., & Isha, A. S. N. (2023). Influence of communication determinants on safety commitment in a high-risk workplace: A systematic literature review of four communication dimensions. *Frontiers in Public Health, 11*, 1225995.

Zou, P. X., Fang, D., Qing Wang, S., & Loosemore, M. (2007). An overview of the Chinese construction market and construction management practice. *Journal of Technology Management in China, 2*(2), 163-176.

Zubaru, H. (2021). *Management of procurement risks in Federal Inland Revenue Service building construction projects in Nigeria* [Master's dissertation]