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ASSESSING THE EFFECTIVENESS OF ENFORCEMENT MECHANISMS IN ENHANCING COMPLIANCE AND DISASTER PREPAREDNESS FOR ENERGY AND PETROLEUM INCIDENTS IN NAIROBI COUNTY, KENYA

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Assessing the Effectiveness of Enforcement Mechanisms in Enhancing Compliance and Disaster Preparedness for Energy and Petroleum Incidents in Nairobi County, Kenya

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Abstract:

Purpose: This study aimed to assess the effectiveness of enforcement mechanisms in promoting compliance and enhancing disaster preparedness for energy and petroleum-related incidents in Nairobi County, Kenya.

Methodology: A descriptive research design employing a mixed-methods approach was used. Quantitative data were collected from

384 respondents—including facility managers, technical personnel, emergency responders, and local residents—via structured questionnaires to assess regulatory compliance, preparedness measures, and perceptions of enforcement effectiveness. Qualitative data were gathered through key informant interviews with senior officials from regulatory and disaster management agencies.

Findings: The study found that regulatory inspections, integration of preparedness requirements into licensing, and clear legal frameworks were highly effective in enhancing compliance and disaster readiness, with mean scores between 4.05 and 4.32. Follow-up inspections and the enforcement of penalties further strengthened preparedness. However, inconsistencies in enforcement and variations in response times across operators were identified.

Unique Contribution to Theory, Practice and Policy: The study advances theory by linking enforcement mechanisms directly to measurable improvements in disaster preparedness. Practically, it highlights strategies such as regular inspections, licensing requirements, and penalty enforcement. For policy, the findings provide evidence-based recommendations for strengthening monitoring systems.

Keywords: *Disaster preparedness, Enforcement mechanisms, Regulatory compliance, Energy sector Petroleum incidents, Safety regulations.*

JEL CODES: Q48, L51, H12, Q40, K20

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1. INTRODUCTION

Energy and petroleum-related incidents, including fuel spills, pipeline leaks, fires, and explosions, are among the most hazardous disasters affecting urban centers. These incidents not only threaten human life and property but also have severe environmental and economic consequences (OCHA, 2020). Nairobi County, as Kenya's capital and a major economic hub, hosts numerous energy and petroleum facilities, making it particularly vulnerable to such disasters. Effective disaster preparedness is therefore essential to minimize risks, protect communities, and ensure the continuity of critical energy services (Ministry of Energy and Petroleum, 2023). Regulatory frameworks and enforcement mechanisms play a central role in shaping disaster preparedness. These mechanisms include inspections, licensing requirements, compliance monitoring, penalties for violations, and emergency drills, all of which aim to ensure that energy and petroleum operators adhere to safety standards. While Kenya has established comprehensive regulations for the energy sector, the effectiveness of these measures depends on consistent enforcement, adequate technical capacity, and active engagement of all stakeholders (Energy & Petroleum Regulatory Authority, 2024).

Despite the regulatory structures in place, studies and incident reports suggest that compliance levels and preparedness practices vary across facilities, highlighting gaps in enforcement and challenges in implementation. Factors such as resource limitations, bureaucratic delays, and low stakeholder awareness can undermine regulatory effectiveness and increase vulnerability to disasters. This study seeks to assess the effectiveness of enforcement mechanisms in ensuring compliance and enhancing disaster preparedness for energy and petroleum-related incidents in Nairobi County. By examining both regulatory practices and stakeholder experiences, the research provides insights into how enforcement contributes to disaster mitigation and identifies areas for improvement to strengthen resilience in the energy sector.

2. LITERATURE REVIEW

Cauchois et al. (2020) examined the "Asset Partner" service model on the Norwegian Continental Shelf (NCS), emphasizing the difficulties and potential for the service sector in offshore petroleum operations. The research investigates the ways in which cooperation between asset owners and service providers might improve operational efficiency, safety, and catastrophe readiness in offshore petroleum operations. It underscores the intricacies of overseeing service relationships, ensuring regulatory compliance, and upholding safety standards in high-risk settings. Cauchois et al. (2020) elucidates the service model's efficacy and its impact on safety, although the study is confined to the Norwegian offshore context, concentrating on operational efficiency and compliance frameworks within a robust regulatory setting. This research seeks to evaluate the efficacy of enforcement methods in promoting compliance and improving disaster preparation for energy and petroleum-related occurrences in Nairobi County, Kenya. The research will investigate the use of enforcement mechanisms, including monitoring, fines, and incentives, within the energy and petroleum sectors of a developing nation, assessing their impact on enhancing disaster

preparation and risk reduction. The Kenyan setting adds complexity due to distinctive issues associated with institutional capability, resource limitations, and local enforcement procedures.

Ncube and Sibindi (2025) investigated the role of regulatory enforcement in oil and gas operations in Zimbabwe. They found that regular inspections, licensing compliance checks, and the imposition of fines for non-compliance significantly influenced operational adherence to safety protocols. Their study emphasized that enforcement mechanisms were not only punitive but also served as motivators for operators to implement robust emergency response plans and preventive measures. However, gaps in institutional capacity, insufficient technical expertise, and delays in executing corrective actions limited the effectiveness of these mechanisms, especially in resource-constrained settings. This finding is particularly relevant to Nairobi County, where similar institutional and logistical challenges may hinder consistent enforcement of disaster preparedness regulations in energy and petroleum sectors.

Mensah et al. (2020) examined regulatory compliance and disaster risk management in Ghana's petroleum storage and distribution sector. Their research demonstrated that enforcement mechanisms—comprising inspections, audits, and mandatory reporting requirements—were critical for reducing accident risks and enhancing overall preparedness. The study also highlighted that coordination between regulatory agencies and facility operators was essential to ensure timely corrective actions and continuous adherence to safety standards. Nonetheless, the study identified limitations including limited human resources, inadequate funding, and occasional non-compliance due to lack of awareness or operational pressures. These constraints mirror the challenges faced in Nairobi County, where enforcement mechanisms must contend with dense urban populations, informal settlements near petroleum infrastructure, and limited capacity among regulatory and disaster response agencies.

Eriksson and Boonstra (2025) study examined the geopolitical dynamics and strategic rivalry in the South China Sea, emphasizing the interests of global powers in the area. The research examined the complicated interactions among governments regarding territorial disputes, security issues, and the global ramifications of these conflicts. It analyzes the interaction of international law, power dynamics, and military positioning in influencing the resolutions of territorial conflicts, emphasizing the involvement of major powers such as China, the United States, and Southeast Asian countries. Stone emphasizes that these wars impact not just regional stability but also global power dynamics, economic routes, and security alliances. This research focuses on local governance and regulatory enforcement regarding energy and petroleum-related hazards in a developing country, contrasting with the previous work that examined international geopolitics and territorial conflicts in the South China Sea. The Kenyan setting presents distinct problems, including institutional capability, economic growth, and community involvement in disaster preparation, which vary from the state-to-state conflicts and global strategic factors examined in Stone's research.

Acheampong et al. (2025) developed a framework for prioritizing capability mechanisms to minimize environmental disaster risks within Ghana petroleum sector. The study focused on

identifying and ranking critical capability mechanisms, such as environmental monitoring, staff training, and emergency response planning, to address risks associated with petroleum operations. The research emphasized the need for comprehensive risk assessment frameworks and proactive capacity-building measures to enhance disaster preparedness. In contrast, this study shifts focus to Nairobi County, Kenya, examining the effectiveness of enforcement mechanisms in ensuring compliance and enhancing disaster preparedness for energy and petroleum-related incidents. Unlike. This divergence highlights the context-specific regulatory challenges in Nairobi and the emphasis on enforcement mechanisms rather than capability prioritization.

Abdalla et al. (2013) conducted a critical evaluation of the petroleum regulatory framework in South Sudan, particularly focusing on the environmental issues associated with petroleum operations. The study assessed how the regulatory framework addresses the environmental impacts of petroleum exploration, extraction, and transportation, emphasizing the need for effective policies, monitoring systems, and environmental safeguards. The above work also highlighted the gaps in the regulatory system, such as insufficient capacity for enforcement, limited public participation, and weak institutional frameworks. The study proposed reforms to enhance environmental protection through stricter regulations and more robust enforcement mechanisms tailored to South Sudan's unique challenges. While the above study centers on environmental protection within South Sudan's petroleum sector, this research expands the scope to include broader disaster risks, such as electrical fires, gas explosions, and power outages, within the context of energy and petroleum operations in Nairobi. The focus here is on assessing how well enforcement mechanisms address not just environmental risks but also safety and disaster preparedness in a metropolitan context. This distinction underscores the emphasis on disaster management in urban settings in Nairobi, as opposed to the predominantly environmental focus of the above research in a less industrialized setting like South Sudan

Khan (2015) examined Kenya environmental regulatory system for the upstream oil and gas sector, emphasizing the implementation of the polluter pays concept. The research assessed the impact of this concept on adherence among industry participants and its role in promoting environmental sustainability. Bett emphasized deficiencies in enforcement methods, such as weak institutional structures and insufficient sanctions, which compromise the efficacy of rules in preventing pollution. The study highlighted the need for stringent enforcement measures to guarantee compliance with environmental regulations in the oil and gas industry. The preceding research examines environmental regulation and pollution management within the upstream oil and gas sector, while the next study will concentrate on disaster preparation for energy and petroleum-related catastrophes in Nairobi County.

Bishoge et al. (2018) conducted a comprehensive examination of the legislative and institutional framework regulating safety and security within Kenya petroleum industry. The research assessed the efficacy of current legislation and institutional frameworks in mitigating safety issues, highlighting obstacles like regulatory redundancies, insufficient enforcement, and restricted stakeholder involvement. He underscored the need for a unified and meticulously planned structure to improve safety and alleviate hazards in the petroleum industry.

The above research generally examined safety and security from legal and institutional viewpoints, while the forthcoming study specifically focuses on the impact of enforcement mechanisms in enhancing disaster preparation for energy and petroleum-related accidents in Nairobi County. It analyzes the practical dimensions of enforcement, including inspections, compliance monitoring, and penalties, specifically regarding disaster preparedness, rather than the wider safety and security issues within the petroleum sector.

Muigua (2019) investigated the management of natural resources and the equitable allocation of benefits derived from them in Kenya. The research elucidates the legal and regulatory frameworks regulating natural resource management and analyzes their effectiveness in addressing sustainability, inclusiveness, and equity concerns. He emphasized the significance of community involvement, transparency, and accountability in guaranteeing that the utilization of natural resources equally benefits all stakeholders. The study examines current deficiencies in implementation and enforcement, providing solutions to enhance governance systems. The preceding study explores the overarching theme of natural resource management and benefit-sharing, whereas the forthcoming study will concentrate on analyzing the function of enforcement mechanisms in enhancing disaster preparedness for energy and petroleum-related incidents in Nairobi County, Kenya.

3. METHODOLOGY

This study adopted a descriptive research design to investigate the influence of regulatory frameworks on disaster preparedness for energy and petroleum-related incidents in Nairobi County. The descriptive design was appropriate because it allowed for a systematic examination of existing enforcement mechanisms, stakeholder engagement, and implementation challenges without manipulating any variables (Siedlecki, 2019). By providing a clear snapshot of the regulatory environment, this approach enabled the study to evaluate the effectiveness of enforcement mechanisms in promoting compliance and enhancing disaster preparedness.

A mixed-methods approach was employed to enrich the analysis. Quantitative data were collected through structured questionnaires administered to 384 respondents, including local residents, energy and petroleum facility managers, emergency responders, and technical personnel. The quantitative data provided measurable insights into compliance levels, preparedness practices, and perceptions of regulatory enforcement, allowing for statistical analysis of patterns and trends (Anichukwueze et al., 2023). Qualitative data were collected through key informant interviews (KIIs) with 10–15 senior officials from regulatory bodies such as EPRA, NEMA, and the National Disaster Management Unit, as well as focus group discussions with community leaders and emergency personnel. These qualitative methods explored stakeholders' experiences, perceptions, and challenges, providing deeper contextual understanding of the enforcement and preparedness landscape.

The study population was carefully defined and sampled to ensure representativeness and depth. Purposive sampling was used to select key informants with specialized expertise in policy implementation, regulatory oversight, and crisis management, while stratified random sampling was employed for local residents to capture diverse perspectives based on geographic location and socioeconomic status. Data from both quantitative and qualitative sources were analyzed using descriptive statistics and thematic analysis, with triangulation applied to enhance validity. This comprehensive methodology ensured that the study captured both measurable outcomes and nuanced insights into the effectiveness of enforcement mechanisms in Nairobi County's energy and petroleum sector.

4. RESULTS

Regulatory inspections significantly enhance compliance and preparedness

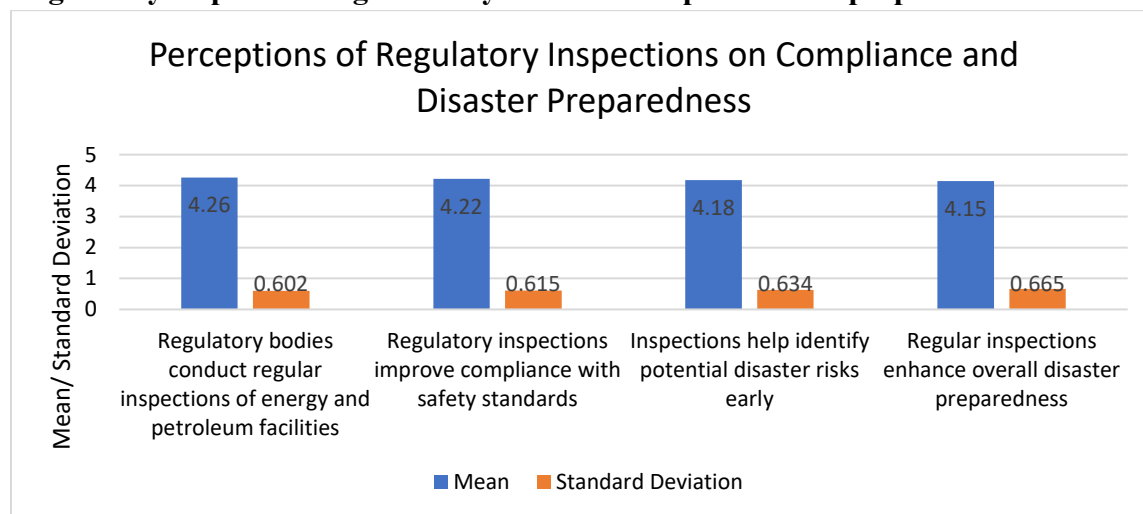


Figure 1: Perceptions of Regulatory Inspections on Compliance and Disaster Preparedness

The findings presented in the Figure 1 above indicate a strong positive perception among respondents regarding the role of regulatory inspections in enhancing compliance and disaster preparedness within the energy and petroleum sector in Nairobi County. The highest mean score ($M = 4.26$, $SD = 0.602$) was recorded for the statement that regulatory bodies conduct regular inspections, suggesting that inspections are not only consistently implemented but are also widely recognized by stakeholders as an integral part of regulatory enforcement. The relatively low standard deviation reflects a high level of agreement among respondents, indicating minimal variation in perceptions across different stakeholder groups.

Further analysis shows that regulatory inspections are perceived to directly improve compliance with safety standards ($M = 4.22$, $SD = 0.615$) and to play a critical role in identifying potential disaster risks at an early stage ($M = 4.18$, $SD = 0.634$). Additionally, respondents agreed that regular inspections enhance overall disaster preparedness ($M = 4.15$, $SD = 0.665$), reinforcing the view that inspections contribute to both preventive and preparedness outcomes. Although this indicator recorded the lowest mean among the four, it still reflects strong agreement, suggesting

that inspections are an effective enforcement mechanism. Overall, the consistency of high mean scores across all statements demonstrates that regulatory inspections significantly strengthen compliance and disaster preparedness, underscoring their importance in mitigating energy and petroleum-related risks in Nairobi County.

Enforcement of penalties acts as an effective deterrent to non-compliance

Table 1: Enforcement of penalties acts as an effective deterrent to non-compliance

Statement	N	Mean	Standard Deviation
Non-compliance with safety standards results in strict penalties	384	4.12	0.648
Penalties discourage unsafe operational practices	384	4.18	0.632
Enforcement actions promote adherence to disaster preparedness measures	384	4.15	0.665
Penalties reduce the likelihood of repeated safety violations	384	4.10	0.672

The results indicate that respondents strongly agreed that non-compliance with safety standards results in strict penalties, as reflected by a high mean score ($M = 4.12$, $SD = 0.648$). This finding suggests that regulatory authorities in Nairobi County have established enforcement systems capable of imposing meaningful sanctions on operators who violate safety requirements. The relatively low standard deviation demonstrates consistency in respondents' perceptions, indicating widespread recognition of penalties as an integral component of regulatory enforcement within the energy and petroleum sector. The study further revealed that penalties are effective in discouraging unsafe operational practices, with this statement recording the highest mean score ($M = 4.18$, $SD = 0.632$). This finding underscores the deterrent effect of enforcement actions, as operators are more likely to comply with safety regulations when the consequences of non-compliance are clear and consistently applied. The low variability in responses suggests a shared understanding among stakeholders that penalties influence operational behavior and promote safer practices.

Additionally, respondents agreed that enforcement actions promote adherence to disaster preparedness measures ($M = 4.15$, $SD = 0.665$). This indicates that penalties not only punish violations but also encourage proactive compliance, such as investing in safety equipment, staff training, and emergency preparedness planning. The findings suggest that enforcement mechanisms contribute to a culture of accountability and preparedness within the sector. Finally, the perception that penalties reduce the likelihood of repeated safety violations ($M = 4.10$, $SD = 0.672$) highlights the long-term impact of enforcement on compliance behavior. Although this indicator recorded the lowest mean among the four, it still reflects strong agreement, demonstrating that penalties play a preventive role in minimizing recurring risks. Overall, the results confirm that enforcement of penalties is a critical deterrent that supports regulatory compliance and enhances disaster preparedness in Nairobi County's energy and petroleum sector.

Follow-up and monitoring mechanisms improve corrective compliance

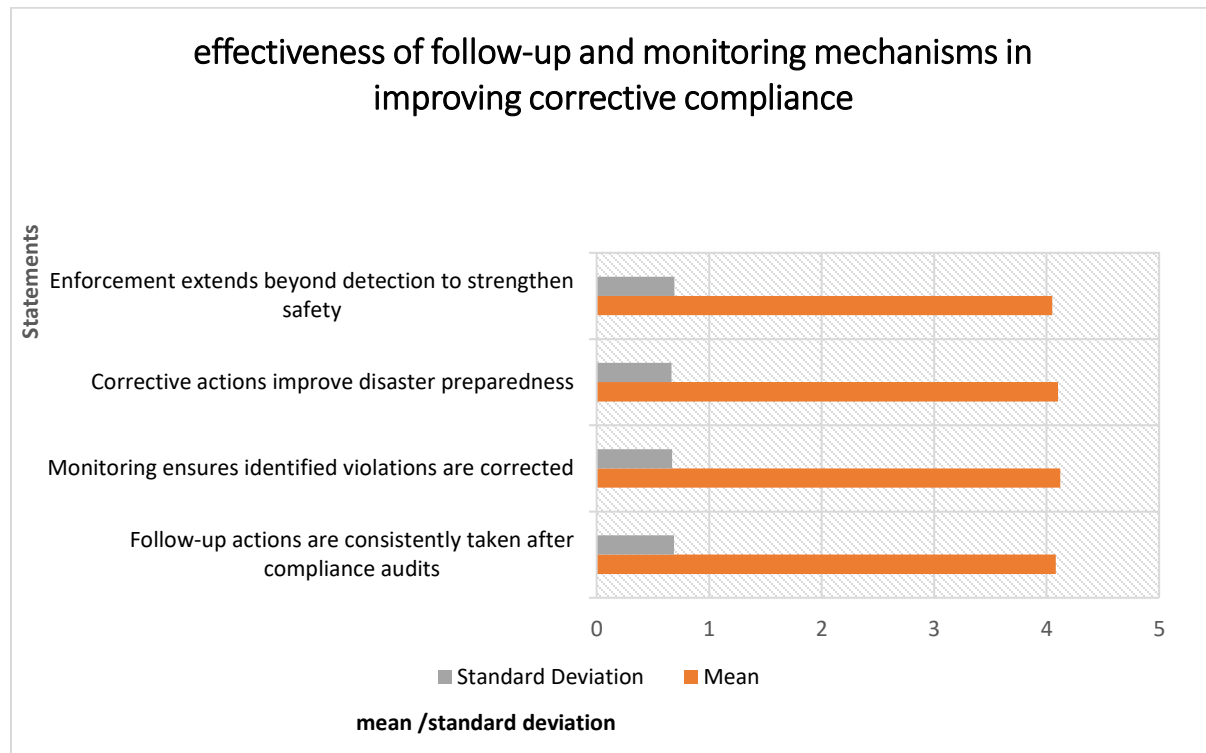


Figure 2: monitoring mechanisms improve corrective compliance

The results on figure 2 above indicate that follow-up actions after compliance audits are generally implemented in Nairobi County's energy and petroleum sector, with a mean score of 4.08 (SD = 0.688). This suggests that stakeholders perceive enforcement mechanisms as extending beyond merely detecting violations to actively ensuring that corrective measures are undertaken. The relatively low standard deviation indicates that this perception is widely shared among respondents, reflecting a consensus on the importance of follow-up in strengthening compliance with disaster preparedness requirements.

Monitoring mechanisms were also rated positively, with respondents agreeing that ongoing supervision ensures identified violations are corrected (M = 4.12, SD = 0.670). This highlights the effectiveness of continuous oversight in maintaining safety standards and reducing risks associated with energy and petroleum operations. By ensuring that violations are addressed promptly, monitoring mechanisms contribute to preventing the recurrence of unsafe practices and enhance operational accountability across facilities.

Respondents further recognized that corrective actions resulting from follow-up procedures improve overall disaster preparedness (M = 4.10, SD = 0.665). This finding suggests that enforcement mechanisms do not only serve a punitive function but also play a proactive role in building institutional capacity, preparedness planning, and risk mitigation. Facilities that implement corrective measures after audits are better equipped to manage potential emergencies, thereby reducing vulnerabilities in the sector.

Finally, the statement that enforcement extends beyond detection to strengthen safety standards received a mean score of 4.05 (SD = 0.692), confirming that regulatory oversight is not limited to inspection alone. While this score is slightly lower than other indicators, it still demonstrates strong agreement that follow-up and monitoring are critical components of an effective enforcement framework. Collectively, these findings underscore that continuous monitoring and corrective compliance significantly contribute to enhancing disaster preparedness and safety within Nairobi County's energy and petroleum sector.

Inconsistencies and capacity gaps limit enforcement effectiveness

Table 2. Inconsistencies and capacity gaps limit enforcement effectiveness

Statement	N	Mean	Standard Deviation
Enforcement mechanisms are applied consistently across all operators	384	3.91	0.752
Enforcement officers have adequate technical capacity to monitor compliance	384	3.94	0.701
Emergency drills are regularly mandated and supervised by regulators	384	3.88	0.729
Variations in enforcement affect disaster preparedness outcomes	384	3.85	0.760

The results indicate that enforcement mechanisms are not applied consistently across all operators, with a mean score of 3.91 (SD = 0.752). While this score reflects general agreement among respondents, it is lower than other enforcement indicators, highlighting variability in how regulations are implemented. The relatively higher standard deviation suggests that experiences differ among respondents, indicating that some facilities may receive more rigorous oversight than others, potentially creating gaps in compliance and disaster preparedness. The technical capacity of enforcement officers was rated slightly higher (M = 3.94, SD = 0.701), suggesting that while officers generally possess adequate skills, there are still gaps that may hinder effective monitoring and supervision. Limited capacity can affect the ability of regulatory personnel to consistently enforce compliance, especially in complex or high-risk operational contexts. Strengthening technical skills through continuous training and capacity-building initiatives could improve the consistency and effectiveness of enforcement practices. Emergency drills were perceived as less consistently mandated and supervised, with a mean score of 3.88 (SD = 0.729). This indicates that while drills are sometimes conducted, they are not universally applied or monitored, reducing their potential to build preparedness and response readiness. The variation in responses highlights the need for standardized protocols and better coordination to ensure that all facilities conduct regular and properly supervised emergency exercises.

Finally, respondents agreed that variations in enforcement directly affect disaster preparedness outcomes ($M = 3.85$, $SD = 0.760$). The lower mean score and higher standard deviation suggest that inconsistencies in application and monitoring can compromise overall safety, leaving some areas or facilities more vulnerable to incidents. Collectively, these findings underscore the importance of enhancing uniform enforcement, improving technical capacity, and standardizing emergency preparedness drills to strengthen compliance and mitigate risks in Nairobi County's energy and petroleum sector.

5. DISCUSSIONS

Regulatory inspections significantly enhance compliance and preparedness

Regulatory inspections were found to be a key factor in promoting compliance with safety standards and improving disaster preparedness in Nairobi County's energy and petroleum sector. The high mean scores reported in the study indicate that stakeholders recognize inspections as a consistent and essential mechanism for enforcing safety regulations. Regular inspections ensure that facilities adhere to prescribed operational and safety standards, reducing the likelihood of accidents such as fuel spills, fires, and explosions. This finding highlights the preventive role of inspections in identifying potential hazards before they escalate into disasters. The study also suggests that inspections contribute to a culture of accountability among facility operators. Knowing that regulatory authorities conduct periodic and systematic checks encourages operators to maintain compliance and invest in safety measures proactively. This observation aligns with existing literature, which emphasizes that frequent inspections increase awareness of safety responsibilities and motivate organizations to implement corrective actions promptly (Vinodkumar & Bhasi, 2020). By reinforcing both preventive and corrective measures, inspections serve as a critical tool for long-term disaster preparedness.

Furthermore, the consistency of inspections plays a significant role in enhancing preparedness across the sector. Facilities that undergo regular inspections are more likely to have emergency plans, staff training, and risk mitigation systems in place. Respondents indicated that inspections not only detect non-compliance but also guide facilities in strengthening safety protocols. This demonstrates that inspections extend beyond enforcement to provide opportunities for learning and continuous improvement, contributing to resilience in high-risk operational environments. Despite these positive perceptions, the study also suggests that the effectiveness of inspections depends on adequate resources and technical capacity within regulatory agencies. Limited personnel, logistical challenges, or irregular inspection schedules can reduce the overall impact of enforcement efforts (Adler et al., 2020). Strengthening regulatory capacity, ensuring frequent and comprehensive inspections, and integrating inspection outcomes into broader disaster preparedness strategies would further enhance compliance and safety in Nairobi County's energy and petroleum sector.

Enforcement of penalties acts as an effective deterrent to non-compliance

The findings indicate that enforcement of penalties is perceived as a strong deterrent against non-compliance with safety standards in Nairobi County's energy and petroleum sector. The high mean score of 4.12 for the statement that non-compliance results in strict penalties suggests that

stakeholders recognize the consequences of regulatory violations. This aligns with the argument by Shimshack and Ward (2022), who found that clearly defined and consistently applied sanctions significantly increase compliance levels in high-risk sectors, as operators are more likely to adhere to rules when consequences are well-known.

Respondents also agreed that penalties effectively discourage unsafe operational practices, with a mean score of 4.18. This supports findings by Bernal et al. (2023), who highlighted that penalties act as both corrective and preventive measures, fostering a culture of safety by motivating operators to implement proactive risk-reduction measures. In the context of Nairobi County, the study suggests that penalties incentivize facilities to maintain operational safety standards, thereby reducing the likelihood of accidents such as spills, fires, or explosions.

Additionally, penalties were found to promote adherence to disaster preparedness measures ($M = 4.15$), reflecting their role in encouraging proactive compliance. Literature by Vu et al. (2025) emphasizes that enforcement mechanisms extend beyond punitive action, influencing organizations to adopt preventive and preparedness practices, including emergency drills and risk assessments. This demonstrates that penalties are not merely reactive tools but also serve to strengthen institutional disaster preparedness and safety culture.

Finally, the perception that penalties reduce the likelihood of repeated safety violations ($M = 4.10$) underscores their long-term preventive impact. Although slightly lower than other indicators, this finding aligns with Judijanto and Saputra (2025), who observed that consistent application of penalties in urban energy sectors helps break cycles of unsafe practices and reinforces compliance norms. Overall, the results indicate that penalties are a crucial component of regulatory enforcement, effectively promoting compliance and enhancing disaster preparedness in Nairobi County's energy and petroleum sector.

Follow-up and monitoring mechanisms improve corrective compliance

The study revealed that follow-up actions after compliance audits are generally implemented, with a mean score of 4.08 ($SD = 0.688$). This indicates that stakeholders perceive enforcement mechanisms as extending beyond mere detection of violations to actively ensuring corrective measures are taken. This aligns with Ferreira et al. (2024), who argued that continuous follow-up is critical in disaster-prone sectors because it ensures that non-compliance is not only identified but also rectified, thereby reducing the risk of future incidents. Regular follow-up fosters accountability and strengthens operational safety culture among facility operators.

Respondents agreed that monitoring ensures identified violations are corrected ($M = 4.12$, $SD = 0.670$), highlighting the effectiveness of ongoing supervision in maintaining safety standards. Literature by Essien et al. (2021) emphasizes that monitoring and verification processes are essential in high-risk sectors, as they reinforce compliance and prevent repeated violations. In Nairobi County, these mechanisms appear to guide facilities in addressing gaps in disaster preparedness, ensuring that corrective measures translate into tangible improvements in operational safety.

Corrective actions were also perceived to improve overall disaster preparedness, with a mean score of 4.10 ($SD = 0.665$). This finding resonates with Xiang (2021), who note that when regulatory

agencies ensure that corrective measures are implemented, organizations are better positioned to manage emergencies effectively. Corrective compliance not only addresses immediate risks but also strengthens institutional preparedness by integrating lessons learned into ongoing safety planning and emergency response procedures.

Finally, the statement that enforcement extends beyond detection to strengthen safety standards received a mean score of 4.05 (SD = 0.692), suggesting strong agreement that monitoring and follow-up are critical to long-term compliance. This is consistent with Urquizo and Torres (2025), who found that enforcement mechanisms incorporating feedback loops and corrective supervision significantly enhance resilience in urban energy sectors. Overall, the findings indicate that follow-up and monitoring mechanisms are essential components of effective regulatory enforcement, ensuring that compliance translates into sustained improvements in disaster preparedness and safety in Nairobi County's energy and petroleum sector.

Inconsistencies and capacity gaps limit enforcement effectiveness

The study revealed that enforcement mechanisms are not consistently applied across all operators, with a mean score of 3.91 (SD = 0.752). This indicates that while regulations exist, their implementation varies across facilities, potentially creating gaps in compliance and disaster preparedness. This finding aligns with Vu et al. (2025), who observed that inconsistent enforcement in urban energy sectors can undermine regulatory effectiveness, leaving some facilities more vulnerable to accidents. Variability in application reduces the overall impact of enforcement and highlights the need for standardization in monitoring practices.

Respondents also indicated that enforcement officers do not always possess adequate technical capacity, with a mean score of 3.94 (SD = 0.701). This suggests that while officers have some level of expertise, gaps in skills, training, and experience may limit their ability to effectively monitor compliance. Literature by Vinodkumar and Bhasi (2020) supports this, noting that regulatory capacity constraints in high-risk sectors can hinder inspections and follow-up, thereby reducing overall preparedness. Strengthening technical capacity through continuous professional development is essential for consistent enforcement.

Emergency drills were reported as not always being regularly mandated or supervised, with a mean score of 3.88 (SD = 0.729). This indicates that while drills are conducted in some facilities, they are not uniformly applied, limiting preparedness for potential disasters. Urquizo and Torres (2025) emphasize that regular and well-supervised drills are critical in ensuring that staff are capable of responding effectively during emergencies. Without consistent drills, facilities may lack readiness, which could compromise disaster response and risk mitigation efforts.

Finally, respondents agreed that variations in enforcement affect disaster preparedness outcomes, with the lowest mean score of 3.85 (SD = 0.760). This highlights the direct impact of uneven enforcement and capacity gaps on safety and resilience. Consistent with Siedlecki (2019), the study suggests that uniform application of regulations, adequate training, and standardization of emergency preparedness practices are essential to mitigate risks. Overall, the findings underscore the need for enhanced resources, technical capacity, and procedural standardization to ensure that regulatory enforcement achieves its intended effect across Nairobi County's energy and petroleum sector.

6. CONCLUSION AND RECOMMENDATIONS

Conclusion

The study found that enforcement mechanisms play a critical role in enhancing compliance and disaster preparedness in Nairobi County's energy and petroleum sector. Regulatory inspections were identified as a key driver of safety compliance, helping to detect potential hazards and promote proactive preparedness measures. Enforcement of penalties was effective in deterring unsafe operational practices and encouraging adherence to disaster preparedness protocols. Follow-up and monitoring mechanisms ensured that corrective actions were implemented, strengthening institutional preparedness and risk mitigation. However, inconsistencies in enforcement, gaps in technical capacity of regulatory officers, and irregular supervision of emergency drills were identified as limitations that reduce the overall effectiveness of enforcement in the sector. Overall, the findings indicate that while regulatory mechanisms positively influence compliance and preparedness, addressing capacity and consistency gaps is essential to achieve optimal disaster resilience.

Practical Implications

The study's findings have important implications for policymakers, regulators, and stakeholders. Policymakers should prioritize the development of clear, enforceable, and uniformly applied regulations to ensure consistent compliance across all energy and petroleum facilities. Regulators can enhance the effectiveness of enforcement by investing in capacity-building initiatives for officers, strengthening monitoring and follow-up systems, and standardizing emergency drills. Energy and petroleum operators and community stakeholders can use these insights to support proactive disaster preparedness measures, integrate compliance into operational planning, and collaborate with regulatory bodies to reduce risks. Effective enforcement mechanisms, when consistently applied, can significantly reduce the likelihood of disasters, protect public safety, and enhance resilience in Nairobi County's high-risk energy sector.

Recommendations

- I. **Strengthen technical capacity of enforcement officers through continuous training and certification programs:** Regular training programs will equip enforcement officers with the latest knowledge and skills required to monitor compliance effectively. Certification initiatives can standardize competencies across all officers, ensuring uniform application of regulations. Enhanced technical capacity will enable officers to identify risks accurately and provide practical guidance to facility operators on disaster preparedness (Shimshack & Ward, 2022).
- II. **Standardize and institutionalize emergency drills across all energy and petroleum facilities:** Emergency drills should follow a consistent framework to ensure all facilities are adequately prepared for potential incidents. Institutionalizing drills as a mandatory requirement will promote regular practice and help staff internalize emergency response procedures (OCHA, 2020). Standardization will also allow regulators to assess preparedness uniformly and identify facilities needing additional support.

- III. **Ensure consistent application of regulations across operators to minimize compliance gaps:** Regulators should apply enforcement mechanisms uniformly, regardless of the size or type of facility, to avoid disparities in compliance. Clear guidelines and standardized protocols will reduce ambiguity and prevent selective enforcement. Consistent application of regulations will enhance overall safety and strengthen trust in the regulatory system.
- IV. **Enhance follow-up and monitoring mechanisms to guarantee that corrective actions are implemented effectively:** Follow-up procedures should be systematically conducted after inspections to verify that identified violations are addressed (Ncube & Sibindi, 2025). Strong monitoring mechanisms will ensure that corrective actions are not ignored or delayed, improving disaster preparedness. This approach will reinforce accountability among facility operators and encourage continuous compliance.
- V. **Increase stakeholder engagement by involving local communities and facility operators in preparedness planning:** Engaging local communities can help identify hazards specific to their areas and promote shared responsibility for disaster management. Involving facility operators in planning will ensure that preparedness measures are practical and tailored to operational realities (Muigua et al., 2019). Collaboration among stakeholders will enhance coordination, information sharing, and overall resilience in emergency situations.
- VI. **Conduct periodic evaluation of enforcement effectiveness to identify gaps and adjust policies:** Regular assessments will help identify weaknesses in enforcement practices and areas where compliance is low. Policy adjustments based on evaluation results can improve efficiency and target resources where they are most needed (Mensah et al., 2020). Continuous evaluation ensures that regulatory mechanisms remain effective and responsive to emerging risks.
- VII. **Encourage further research on the impact of regulatory enforcement on disaster outcomes in other counties or sectors:** Studying different regions and sectors can provide comparative insights into best practices and challenges in regulatory enforcement. Research can help identify innovative approaches that improve disaster preparedness and compliance. Expanding knowledge in this area will inform policymakers and regulators, leading to evidence-based improvements in safety standards and emergency management (Judijanto & Saputra, 2025).

Further Research

While this study focused on Nairobi County, further research is needed to explore the effectiveness of enforcement mechanisms in other counties and regions of Kenya to determine whether findings are consistent across different contexts. Comparative studies could examine rural versus urban energy and petroleum facilities, as well as variations across public and private operators, to understand how regulatory challenges differ by location and ownership. Additionally, future research could investigate the long-term impact of enforcement mechanisms on disaster outcomes, including the effectiveness of follow-up actions, emergency drills, and penalty systems in reducing actual incidents.

Exploring stakeholder perceptions over time through longitudinal studies could provide insights into the sustainability of compliance and preparedness efforts, as well as how continuous regulatory engagement influences organizational behavior. Research could also assess the role of technology, such as digital monitoring systems, early warning mechanisms, and data-driven compliance tracking, in enhancing regulatory effectiveness. Finally, studies examining the cost-effectiveness of different enforcement strategies could guide policymakers in allocating resources efficiently while maximizing disaster preparedness and safety in the energy and petroleum sector.

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