

ASSESSING GOVERNANCE FRAMEWORK FOR EMERGENCY PREPAREDNESS AND RESPONSE TO BIOCHEMICAL AND RADIOLOGICAL HAZARDS IN MOMBASA COUNTY, KENYA

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ABSTRACT

Biochemical and radiological agents pose significant threats due to their dual-use nature and potential for catastrophic consequences, as evidenced by incidents like the 2020 Beirut explosion and the 1986 Chernobyl disaster. In Kenya, Mombasa County which is characterized by a diverse base of industries with a strategically located coastal port, exhibits a high vulnerability to such hazards due to high volume of goods or materials handled for domestic use and in transit to other inland countries. The purpose of the study was to assess the governance framework for emergency preparedness and response to biochemical and radiological hazards in Mombasa County. The study utilized an exploratory research design. Stratified random sampling was used to select a sample size of 333 respondents from a target population of 2,000. Questionnaires and interview schedules were the tools used for data collection. Quantitative data was analyzed using descriptive statistics, while qualitative data was analyzed thematically. Key findings revealed critical gaps in interagency coordination, with 64.6% of respondents expressing concerns, and inadequacies in training programs, as noted by 53.1% of respondents. Additionally, 69.4% highlighted deficiencies in emergency response equipment. The study concludes that Mombasa County faces substantial challenges in emergency preparedness, interagency coordination, and investments in training and equipment to improve emergency preparedness capabilities for effective response. The study recommends the development and implementation of comprehensive emergency management policies, enhanced interagency coordination, and regular joint training for enhancement of biochemical and radiological emergency preparedness.

Keywords: Biochemical and radiological hazards, emergency preparedness, response, governance, and interagency coordination



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INTRODUCTION

Biochemical and radiological emergencies refer to incidents involving hazardous substances, posing significant threats to public health, the environment, and global security. These emergencies can arise from accidental events, negligence, or deliberate actions with malicious intent, as highlighted by Sharma (2022). Notable historical events, such as the 1984 Bhopal gas tragedy and the 2001 anthrax attacks in the United States, underscore the severe impact of these emergencies on public safety and emphasize the necessity of stringent safety protocols within industrial sectors (Bogard, 2019; Hillyer, 2021). Similarly, radiological disasters like Chernobyl (1986) and Fukushima (2011) have led to widespread radioactive contamination, raising global awareness about nuclear safety and the vulnerability of nuclear power plants to natural hazards (Ludovici et al., 2020; Murata & Karwowski, 2021). These events illustrate the long-lasting consequences of biochemical and radiological incidents, which often necessitate multiagency coordination and preparedness.

The governance and regulation of biochemical and radiological emergencies present a multi-tiered framework that operates at global, regional, national, and local levels. International organizations like the World Health Organization (WHO), the International Atomic Energy Agency (IAEA), and the Organization for the Prohibition of Chemical Weapons (OPCW) establish critical global standards and guidelines. For instance, the International Health Regulations (IHR) by WHO guide global public health emergency responses, including biochemical and radiological threats, while the IAEA and OPCW provide specific frameworks for nuclear safety and chemical weapon management, respectively. However, studies such as those by Vermonte et al. (2020) and Rocchi et al. (2020) point out gaps in integrating these international frameworks into local governance systems, such as in Mombasa County, Kenya, which often limits their practical effectiveness.

At the regional level, the African Nuclear-Weapon-Free Zone Treaty (Pelindaba Treaty) and partnerships with organizations like the African Union play a significant role in shaping emergency preparedness strategies across Africa. However, as Lysenko et al. (2022) highlight in their comparative analysis, clear legal mandates, regulatory structures, and the availability of essential resources, such as medical supplies and surveillance systems, are crucial for regional preparedness but often lack proper integration with local systems. Similarly, in Kenya, national frameworks like the National Disaster Risk Management Policy (2017) and the National Radiological Emergency Response guidelines exist, but their success hinges on robust coordination and collaboration among entities like the Kenya Nuclear Regulatory Authority (KNRA), the National Police Service (NPS), and local stakeholders, as noted by Mududa (2021).

At a national level, the 2002 Mombasa attack was a two-pronged terrorist attack on 28 November 2002 in Mombasa, Kenya against an Israeli-owned hotel and a plane belonging to Arkia Airlines. An all-terrain vehicle crashed through a barrier outside the Paradise Hotel and blew up, killing 13 and injuring 80. At the same time, attackers fired two surface-to-air missiles at an Israeli charter plane. The Paradise Hotel was the only Israeli-owned hotel in Mombasa. The Paradise Hotel terror attack in 2002 in Mombasa and the Westgate terror attack in 2013 in

Nairobi showed operation decay. The Westgate terror attack siege lasted 80 hours and resulted in at least 67 deaths and more than 175 people wounded in the mass shooting. A fatal friendly fire incident between security forces undermined the response and left the attackers free to prolong their slaughter (Odhiambo 2023).

Mombasa County's role in implementing disaster prevention and mitigation frameworks is critical for ensuring an effective response to biochemical and radiological hazards. Local authorities and health departments are at the forefront of translating national and international guidelines into actionable plans tailored to the unique challenges of the area. Odhiambo (2023) underscores the importance of tailoring response strategies to local demographics and infrastructure, as well as ensuring that there is strong communication and coordination between local, national, and regional authorities. Such integration is crucial for overcoming challenges in preparedness and response and for ensuring that the governance frameworks remain adaptable to evolving threats.

The rising threat of terrorism has amplified concerns regarding the use of biochemical and radiological materials, as seen in the devastating 2020 Beirut explosion, which resulted in significant loss of life and economic damage (Al-Hajj et al., 2021). Such emergencies highlight the need for robust international frameworks, established by organizations like the WHO and IAEA, to address the challenges posed by these hazards. While Kenya has not yet faced a major radiological disaster, the growing use of nuclear and radiological technology in medicine and energy sectors underscores the need for enhanced preparedness. While the Government of Kenya has made strides in implementing regulatory frameworks and collaborating with international partners to improve emergency preparedness capabilities, there is scanty empirical evidence of these efforts leaving Mombasa County to the mercies of God since there is inadequate information of evidential value to inform preparedness planning and disaster risk governance.

It is against the above backdrop that this study sought to assess the biochemical and radiological emergency preparedness governance frameworks for effective response in Mombasa, County, Kenya. It is palatable to note that this objective was met as this scientific investigation resulted to reliable outcome that would form the premise upon which evidence-based preparedness will be empaneled in future. This study no doubt contributes to the body of knowledge filling the gap that was, and outrightly charging responsible institutions to bridge the identified governance loopholes for a better preparedness Mombasa County.

METHODOLOGY

The study employed an exploratory research design to assess biochemical and radiological emergency preparedness in Mombasa County, using a mixed-methods approach to capture both quantitative and qualitative data. This design was essential given the lack of prior research and the complex, evolving nature of such emergencies (Witt, 2019). The research explored governance, training, and equipment management within the unique sociopolitical, economic,

and cultural context of Mombasa, allowing for a comprehensive understanding of local emergency preparedness dynamics.

The study targeted 2,000 respondents from Mombasa County, Kenya, including community leaders, emergency responders, county government officials, government agencies, healthcare institutions, and community organizations. Community leaders provided grassroots perspectives on emergency preparedness challenges and strengths, while emergency responders offered insights into operational aspects like training and equipment use. County officials contributed valuable governance and policy-related viewpoints. Engagement with government agencies facilitated understanding of inter-agency coordination and resource allocation, and healthcare professionals highlighted the medical preparedness for biochemical and radiological emergencies. Community organizations played a key role in promoting awareness and community-driven emergency preparedness strategies. Table 1 shows summary of target population

Table 1
Target Population

Category	Population (N)	Percentage (%)
Government agencies	900	45
Health care workers	700	35
Community organization leaders	400	20
Total	2000	100

The study employed a stratified random sampling technique to ensure comprehensive representation across various sectors involved in emergency preparedness, segmenting the population into subgroups such as governmental agencies, healthcare institutions, and community organizations, as outlined by Berndt (2020). This approach allowed for detailed and accurate analysis by ensuring adequate representation from each subgroup. Additionally, purposive sampling was used to select key informants with specialized knowledge, including county government officials, emergency responders, and community leaders, following Rosen (2019) guidance on selecting participants based on their relevant expertise. Table 2 shows the study sampling techniques.

Table 2: *Sampling Techniques*

Category	Sampling technique
Community leaders	Purposive sampling
Emergency responders	Purposive sampling
County government officials	Purposive sampling
Government agencies	Stratified random sampling
Healthcare care workers	Stratified random sampling
Community organisation leaders	Stratified random sampling

The sample size from the government agencies, emergency responders and county government officials were 333, calculated using Slovin's Formula (Nyimbili & Nyimbili, 2024).

Questionnaires were used to ensure uniform data collection, offering a consistent set of questions to all participants, which facilitated the comparison of responses across various contexts (Krosnick, 2017). A total of 333 questionnaires were distributed via Google Forms to individuals with smartphones and adequate network access, while physical copies were provided to those without. The questionnaires employed a 5-point Likert scale and closed-ended questions to assess preparedness and response strategies for biochemical and radiological emergencies in Mombasa County. Additionally, Key Informant Interviews (KII) were conducted with 10 individuals in leadership positions within government and community organizations, providing valuable qualitative insights that enriched the data collection.

Quantitative data was analyzed using descriptive statistics, with findings presented through tables, charts, and graphs, while qualitative data was thematically analyzed to highlight key patterns and themes, providing a comprehensive understanding of emergency preparedness in Mombasa County.

Prioritizing the welfare, rights, and confidentiality of participants was of utmost importance. Engagement in the research was completely optional, and individuals had the freedom to discontinue their involvement at any point without experiencing adverse repercussions. During the recruitment of informants, the researcher highlighted the voluntary aspect of participation and ensured that participants were fully informed about their right to withdraw. The privacy of participants was upheld throughout the study, and their personal information was not revealed without explicit consent. The researcher administered interviews and surveys in confidential environments, and the data was securely stored and exclusively accessible to the researcher. The researcher also sought authorization from the National Defence University – Kenya and acquired a research permit from NACOSTI. Additionally, the researcher obtained permission from competent authorities to conduct the study within their institutions.

RESULTS

Demographic Information

Demographic analysis revealed that the majority (66%) of respondents were male, while the remaining (44%) were female.

The age distribution showed a predominance of mid-career professionals aged 41-50 years (44%), suggesting a workforce with significant experience but fewer younger and older participants, which may affect perceptions of emergency preparedness (Xiang, 2022).

Additionally, most respondents were from government agencies (53%) and held undergraduate degrees (52%), indicating a workforce with substantial, albeit variable, educational backgrounds that could influence their perspectives on emergency preparedness and response.

Biochemical and Radiological Emergency Plans

Participants were asked to indicate their agreement on whether their organizations had comprehensive biochemical and radiological emergency plans. Figure 1 shows the distribution of the respondents by presence of comprehensive energy plans.

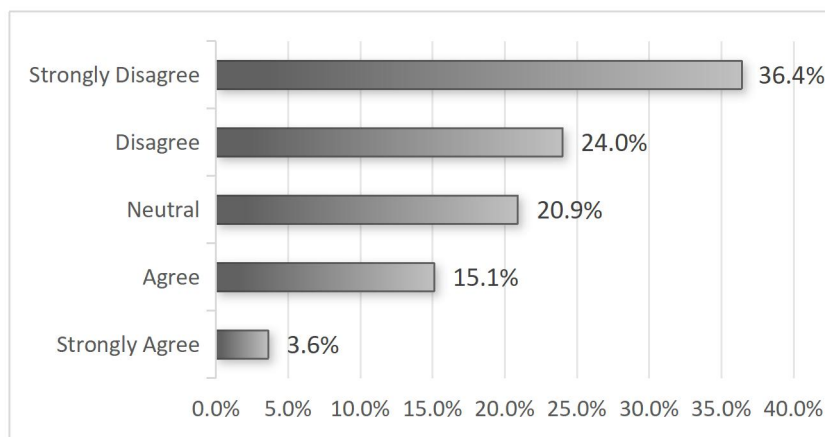


Figure 1: *Presence of Comprehensive Emergency Plans*

The majority (36.4%) strongly disagreed, 24% disagreed, 20% were neutral, 15.1% agreed, and 4.6% strongly agreed, highlighting gaps in emergency planning.

This is corroborated by key informants' perspectives, with one respondent highlighting that:

We don't have any emergency protocols including preparedness levels. We have introduced 2 of our sailors to Vessel Board Search and Seizure (VBSS) operations while offering specialized training in NSDD (Nuclear Smuggling Deterrence and Detection) as we build our NSDD Capabilities. Indeed, there is greater need to develop these national capabilities (Respondent, KII01, 2024).

In addition, respondent 2 had the following to say "Biochemical and radiological preparedness should be mandatory in all organisations since the threat is real and is a concerned globally"

Interagency Coordination Mechanisms for Biochemical and Radiological Emergencies

Respondents were asked to express their level of agreement regarding the effectiveness of interagency coordination mechanisms for biochemical and radiological emergencies in Mombasa County, Kenya. The outcomes presented in Figure 2 shows the distribution of the respondents by Effectiveness of Interagency Coordination Mechanism.

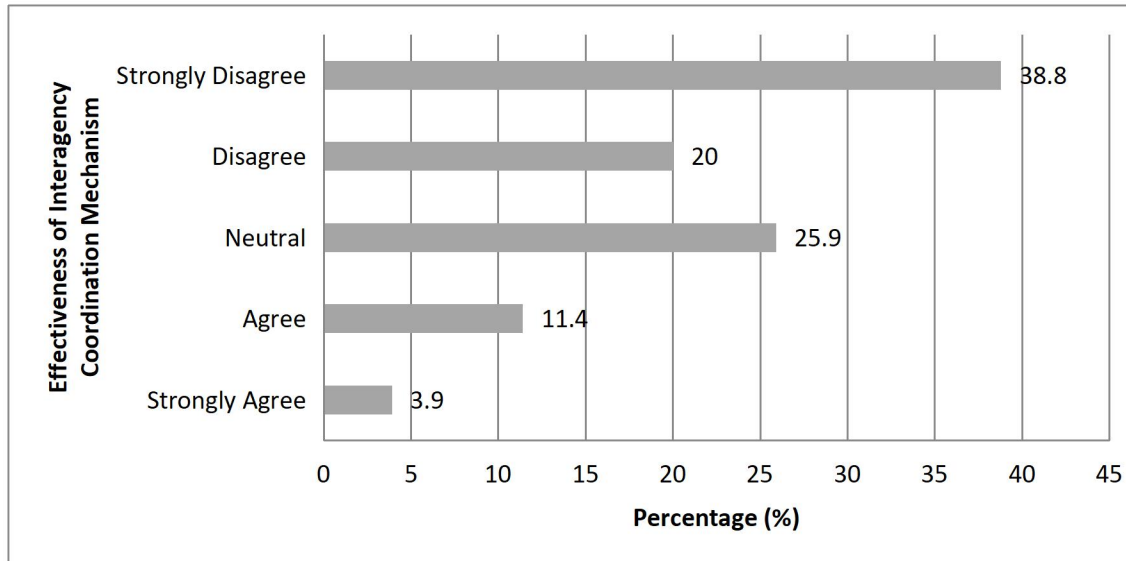


Figure 2: *Effectiveness of Interagency Coordination Mechanism*

The finding reveals a prevalent perception of ineffective interagency coordination mechanisms for biochemical and radiological emergencies in Mombasa County, with 38.8 per cent of respondents strongly disagreeing and 20 per cent disagreeing with the effectiveness of these mechanisms. A considerable portion (25.9%) remains neutral, indicating uncertainty or variability in experiences.

In the same line, the seventh key informant said that:

The Emergency Preparedness and Response stakeholders, particularly the National Security Agencies need to scale up their readiness for CBRN hazards. CBRN emergencies are happening and we must be prepared for any event (Respondent, KII07, 2024)

Stakeholder Engagement Strategies for Biochemical and Radiological Emergency Preparedness

The other key aspect examined was implementation of community engagement strategies by organizations to raise awareness about biochemical and radiological emergency preparedness and response. Participants were asked to express their level of agreement with the statement that their organization employs community engagement strategies. The study results presented in Figure 3 shows the distribution of the respondents.

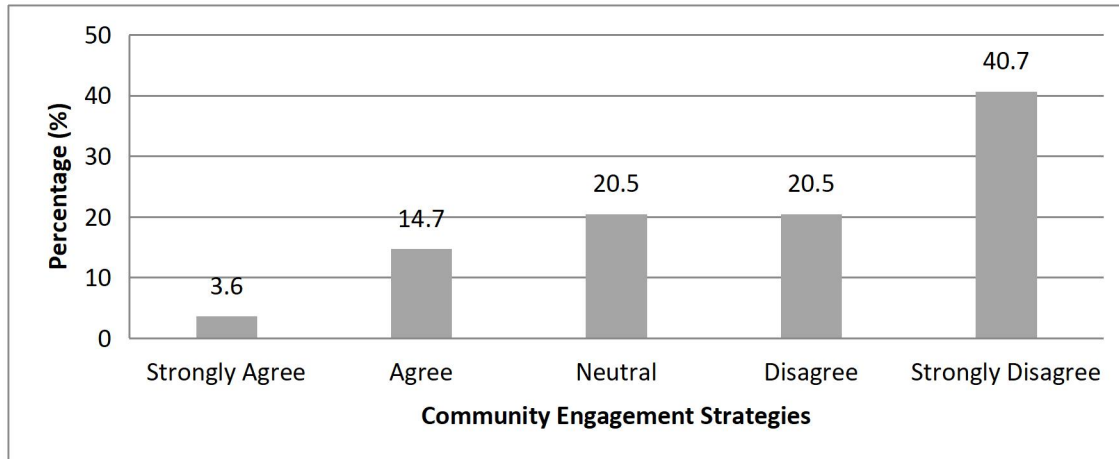


Figure 3: *Community Engagement Strategies*

Less than a half (40.7%) of the respondents strongly disagreed with the statement, 20.5% disagreed, while only 14.7% of them agreed with the statement that organization employs community engagement strategies for Biochemical and Radiological Emergency Preparedness

In the same line, the fifth key informant also had the following to say:

The community is not aware of the dangers of these things and how they can be attended to in the event of an emergency. There is need to create awareness to the people of Mombasa County, by educating them on biochemical and radiological preparedness (Respondent, KII05, 2024).

DISCUSSION

The findings brings out a critical gap in preparedness for biochemical and radiological emergencies in organizations, reflecting systemic inadequacies in policy frameworks, training, and enforcement mechanisms. A significant proportion of respondents highlighted the absence of comprehensive emergency plans, which aligns with Hossain's (2020) assertion that disaster preparedness must be a central component of organizational planning to effectively mitigate losses and damages. This lack of preparedness is symptomatic of broader structural challenges, including limited investments in disaster management infrastructure and insufficient prioritization of biochemical and radiological risks.

The urgency to develop and implement robust emergency protocols and capabilities, such as Nuclear Smuggling Deterrence and Detection (NSDD), as highlighted by key informants, finds support in the work of Ahmadi et al. (2024), who stressed the role of specialized training and technical readiness in enhancing emergency response capabilities. Their study demonstrated that advanced training programs significantly improve organizational resilience, a finding echoed in

this study's results. Furthermore, the introduction of protocols like Vessel Board Search and Seizure (VBSS) operations aligns with global best practices that advocate for incorporating targeted operational strategies in preparedness efforts.

Stricter licensing and enforcement mechanisms, as suggested by the respondents, are critical for enhancing compliance and safety standards. These recommendations are consistent with the findings of Corbin et al. (2021), who emphasized that regulatory oversight and strict enforcement are fundamental in creating a culture of safety and accountability. The integration of these mechanisms could address the gaps in policy implementation and ensure adherence to safety protocols.

Moreover, the findings resonate with broader challenges highlighted in disaster management literature, particularly in resource-constrained settings. Studies such as by Smith et al. (2019) have noted that inadequate preparedness often stems from fragmented governance, insufficient interagency collaboration, and a lack of stakeholder engagement. Addressing these systemic challenges requires not only policy reforms but also investments in capacity-building and multi-sectoral collaboration to develop a cohesive and effective response framework. Such efforts are essential to ensure organizational and community resilience against biochemical and radiological threats.

CONCLUSION

The study uncovered significant shortcomings in Mombasa County's preparedness for biochemical and radiological emergencies, driven by inadequate emergency plans, weak interagency coordination, and limited training efforts. These challenges highlight systemic gaps in governance and resource allocation, compromising the county's overall readiness to handle such hazards effectively. The divergence in stakeholder perceptions underscores the complexity of addressing these issues and the need for a unified and strategic approach to strengthen resilience and emergency response capabilities.

Based on the study's findings, which reveal a significant lack of comprehensive emergency plans and ineffective interagency coordination in Mombasa County, it is recommended that governance and coordination frameworks be strengthened through the development and implementation of robust biochemical and radiological emergency management policies and plans across all organizations involved in emergency response. Enhancing interagency coordination is crucial and can be achieved through regular communication, joint training exercises and drills, and the establishment of clear protocols to streamline response efforts and address potential gaps before, during, and after emergencies. Furthermore, future research should incorporate objective measures or observational data to validate and supplement self-reported results, ensuring more accurate insights. Comparative analyses across different counties or regions within Kenya are also recommended to explore variations in governance frameworks, training programs, and resource availability, which could inform tailored strategies for improving emergency preparedness.

ABOUT AUTHOR

Amos Onchiri Anyieni is a Master of Arts in Crisis Response and Disaster Management student at the National Defence University Kenya (NDU – K). This academic paper is based on the findings and recommendations of the first objective of his master’s thesis on “Biochemical and Radiological Emergency Preparedness for Effective Response in Mombasa County, Kenya”.

REFERENCES

- Berndt, A. (2020). Sampling methods. *Journal of Human Lactation*, 36(2), 224–226. <https://doi.org/10.1177/0890334420906850>
- Bogard, W. (2019). The Bhopal tragedy. In Routledge eBooks. <https://doi.org/10.4324/9780429309083>
- Corbin, J. H., Oyene, U. E., Manoncourt, E., Onya, H., Kwamboka, M., Amuyunzu-Nyamongo, M., ... & Van den Broucke, S. (2021). A health promotion approach to emergency management: effective community engagement strategies from five cases. *Health promotion international*, 36(Supplement_1), i24-i38.
- Corbin, J. H., Oyene, U. E., Manoncourt, E., Onya, H., Kwamboka, M., Amuyunzu-Nyamongo, M., ... & Van den Broucke, S. (2021). A health promotion approach to emergency management: effective community engagement strategies from five cases. *Health promotion international*, 36(Supplement_1), i24-i38.
- Hillyer, K. (2021, October 6). Fear and the unprepared: United States bioterrorism policy and the 2001 anthrax crisis. <https://hdl.handle.net/10214/26512>
- Hossain, B. (2020). Role of organizations in preparedness and emergency response to flood disaster in Bangladesh. *Geoenvironmental Disasters*, 7, 1-16.
- Ludovici, G. M., Souza, S., Chierici, A., Cascone, M. G., D’Errico, F., & Malizia, A. (2020). Adaptation to ionizing radiation of higher plants: From environmental radioactivity to chernobyl disaster. *Journal of Environmental Radioactivity*, 222, 106375. <https://doi.org/10.1016/j.jenvrad.2020.106375>
- Murata, A., & Karwowski, W. (2021). On the Root Causes of the Fukushima Daiichi Disaster from the Perspective of High Complexity and Tight Coupling in Large-Scale Systems. *Symmetry*, 13(3), 414. <https://doi.org/10.3390/sym13030414>

- Nyimbili, F., & Nyimbili, L. (2024). Types of purposive sampling techniques with their examples and application in qualitative research studies. *British Journal of Multidisciplinary and Advanced Studies*, 5(1), 90-99.
- Rocchi, F., Devol-Brown, I., & Raskob, W. (2020). Nuclear and radiological emergency management and preparedness. *EPJ Nuclear Sciences & Technologies*, 6, 37.
- Sharma, S., Sharma, R., & Singh, R. K. (2022). Mayapuri radiological catastrophe: good practices and the lessons learnt. *Current Radiopharmaceuticals*, 15(1), 21–31. <https://doi.org/10.2174/1874471014666210118123424>