

Editorial

Evaluating the Safety Practices in Sewerage Projects in Addis Ababa

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Abstract

This study evaluated safety practices in sewerage projects in Addis Ababa using a descriptive survey design. A sample of 132 participants was selected through purposive sampling, focusing on individuals with firsthand experience in sewage projects. Data collection included primary and secondary sources. A quantitative approach was employed, utilizing closed-ended questionnaires on a Likert scale distributed to contractors, consultants, and clients. SPSS 26 was used for data analysis, and the Relative Importance Index was used to rank strategies for enhancing safety practices based on perceived importance. The survey results indicated that 76% of respondents disagree with the provision of mandatory safety training programs for all workers before starting sewerage project work. About 24.8% of respondents believe that the supply of Personal Protective Equipment (PPE) is adequate, pointing to a widespread concern regarding insufficient availability of essential safety gear on-site. Access to first aid kits and emergency medical assistance is reported, yet concerns remain about risk assessments and confined space protocols. Although training for handling hazardous materials exists, there is inconsistent agreement on safety audits and air quality monitoring. Workers in sewerage projects face significant health hazards, including exposure to toxic gases like hydrogen sulfide, lack of vaccinations for diseases such as hepatitis and tetanus, and risks from biological hazards in sewage. Additional concerns include potential hearing loss, ergonomic injuries, slips, trips, and falls, as well as musculoskeletal disorders from heavy lifting and psychological stress from working conditions. Risks related to confined spaces and inadequate training to identify health hazards complicate their challenges. The top five strategies identified to enhance safety practices in sewerage projects include the allocation of additional funding for better quality Personal Protective Equipment (RII=0.924), implementation of advanced monitoring technologies, such as gas detectors and air quality monitors (RII=0.921), regular training programs for workers on safety procedures (RII=0.92), establishment of regular safety audits (RII=0.908), and creation of a dedicated safety management team (RII=0.907). Stakeholders, including government agencies and contractors, must collaborate to implement these strategies effectively to mitigate health risks and enhance safety in

Keywords

Safety Practices, Sewerage Projects, Addis Ababa

1. Introduction

Construction site safety is vital for preventing worker injuries, fatalities, and illness due to hazards like working at heights, handling machinery, and exposure to toxic substances

[1]. Effective health and safety practices, such as risk assessments, proper training, and protective equipment, enhance productivity and morale [2]. In Ethiopia, poor safety standards

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and limited resources heighten risks [3]. Globally, the use of appropriate gear and training is essential [4], especially in developing countries where sanitation-related diseases remain a concern [5, 6]. Unsafe handling of greywater and excreta increases the risk of disease [7, 8]. Sewer systems, while crucial, expose workers to hazardous conditions, including toxic gases and pathogens, posing significant health risks [9-11]. These are worsened by limited training in low-resource settings [12]. Nevertheless, sewage workers are key to public health and environmental sustainability [13]. In Addis Ababa, the sewerage project necessitates thorough safety measures, training, and equipment to protect workers at all stages.

Safety is a crucial aspect of the construction industry, requiring the active involvement of all workers. Varying safety awareness levels on construction sites demand tailored training and communication [14, 15]. In Addis Ababa, rapid construction growth has raised safety concerns due to inadequate designs, insufficient protection for workers, and compromised material quality and supervision [16]. Many projects fail to implement vital health and safety precautions, creating significant management challenges [17].

Sewerage work, being highly hazardous, exposes workers to physical, chemical, and biological risks. Despite global safety standards, conditions for sewerage workers in Addis Ababa remain poor due to inadequate PPE, limited training, and weak regulation enforcement. This results in serious health issues, including infections, respiratory problems, and fatalities. Confined and poorly ventilated workspaces further elevate risks. The lack of institutional frameworks to enforce safety measures highlights the need for comprehensive reforms, including targeted training, proper equipment, and enforceable safety protocols suited to local conditions.

The objective of this study was, therefore, to assess the existing safety protocols and practices implemented, to identify potential health hazards and factors posed by sewerage projects to workers, and to develop strategies for enhancing safety practices in sewerage projects in the city.

2. Research Methodology

2.1. Research Design

The research adopted a quantitative approach, utilizing structured questionnaires to collect data from contractors, consultants, and clients involved in sewerage projects within the city. This method was chosen to allow for the systematic gathering and analysis of numerical data that would offer insights into occupational safety practices.

The research design was descriptive survey-based, aimed at identifying the key safety challenges and evaluating existing practices and strategies. This approach was also instrumental in applying descriptive statistical tools to present findings in line with the research objectives. The data collection process involved not only structured surveys but also site visits to the

sewerage project locations for first-hand observation. Additionally, the research referred to secondary sources, such as safety reports and manuals, to strengthen the analysis.

For sampling, a non-probability purposive (judgmental) technique was employed. Participants were selected based on their direct involvement in the sewerage line systems and treatment components, ensuring they had substantial knowledge of safety practices in Addis Ababa's sewerage projects.

2.2. Research Methods

The target population included professionals from three major stakeholder groups: clients, consultants, and contractors. Given the impracticality of surveying the entire population, the study used Cochran's formula to determine an appropriate sample size. However, the total population was finite (200 professionals). Cochran's formula was used to calculate the sample size (n_0), where z is the value linked to the confidence level (1.96 for 95%), p is the estimated proportion in the population (assumed to be 0.5), and e is the acceptable margin of error (set at 5%). This gives a reliable sample size estimate with 95% confidence.

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2} \quad (1)$$

$$n_0 = \frac{1.96^2 \cdot 0.5 \cdot (1-0.5)}{0.05^2} = 385$$

The sample was adjusted using Cochran's correction formula for finite populations.

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad (2)$$

$$n = \frac{385}{1 + \frac{385 - 1}{200}} = 132$$

Where n is the adjusted sample size, and N is the target population size. Accordingly, the question was distributed to 132 respondents.

Descriptive statistical tools such as frequencies, percentages, means, and standard deviations were used to summarize the data and make it easier to understand. The results were organized and displayed using graphs, tables, and frequency distributions, with percentages calculated to offer clearer insights.

To perform the analysis, the researchers used the Statistical Package for the Social Sciences (SPSS), which provided the necessary tools for efficient data handling. The outcomes of these analyses were presented through tables and percentages.

Additionally, to determine the most effective strategies for enhancing safety practices, the study calculated the Relative Importance Index (RII). This method enabled the ranking of various strategies based on their perceived importance, offering a structured way to prioritize the most impactful ap-

proaches.

3. Discussion

3.1. Demographic Information of the Respondents

The study achieved a high response rate of 94.7%, with 125 out of 132 targeted respondents completing the questionnaire, exceeding the 60% benchmark set by [18] for acceptable analysis. The demographics showed a gender split of 64% male and 36% female. Most respondents had 5-10

years of experience (38.4%), with others falling into 10-15 years (20.8%), 15-20 years (20%), 0-5 years (12%), and over 20 years (8.8%).

In terms of education, 52% held a bachelor's degree, 29.6% had a master's, 13.6% had a diploma, and 4.8% had a PhD. Clients formed the largest job category at 55.2%, while consultants and contractors each made up 22.4%. Among job positions, site engineers were most common (23.2%), followed by office engineers and contract administrators (9.6% each), surveyors (8.8%), safety engineers (8%), foremen (6.4%), and quantity surveyors (5.6%). An additional 8% were in other roles, indicating a diverse professional background.

Table 1. Demographic information of the respondents.

Respondent	Response	Frequency	Percent
Gender	Male	80	64
	Female	45	36
Years of work experience	0-5 years	15	12
	5-10 years	48	38.4
	10-15 years	26	20.8
	15-20 years	25	20
	Above 20 years	11	8.8
Educational status	Diploma	17	13.6
	Degree	65	52
	Master's degree	37	29.6
	PhD	6	4.8
Job category	Client	69	55.2
	Consultant	28	22.4
	Contractor	28	22.4
	Total	125	100

3.2. Safety Protocols and Practices Implemented in Sewerage Projects

The study highlights significant deficiencies in the implementation of safety protocols on sewerage project sites, with respondents expressing concern about inadequate safety measures. A large proportion of workers (76%) lack mandatory safety training before starting tasks, while 75.2% reported that essential Personal Protective Equipment (PPE), such as gloves, helmets, and face masks, is not provided. Additionally, safety signs and hazard warnings are often absent, as reported by 72% of respondents, further contributing

to unsafe working conditions.

Other critical issues include a lack of routine inspections for safety equipment (75.2%) and insufficient access to emergency medical services (78.2%). Risk assessments and confined space entry procedures, which are crucial for identifying and mitigating hazards, were also reported as absent by a majority of respondents (76.8%). Additionally, 75.2% indicated that there are no formal systems for accident reporting, and 74.4% noted a lack of training in handling hazardous materials.

The study also shows that there are no regular safety audits (76.8%) or air quality monitoring systems in place for confined spaces, which are essential for detecting harmful

gases. Furthermore, 76% of respondents agreed that there is inadequate control over exposure to toxic gases and chemicals, indicating a serious oversight in health and safety practices.

The comparison in Figure 1 highlights differing stakeholder perceptions regarding safety protocols in sewerage projects among clients, consultants, and contractors. Overall, clients reported the most favorable views, consistently giving the highest mean scores across all safety measures. They viewed practices like the presence of safety signs (mean = 2.49), provision of personal protective equipment (PPE) (mean = 2.42), and equipment maintenance (mean = 2.36) as well-implemented.

Contractors, on the other hand, gave the lowest ratings, particularly in areas like periodic safety training and first aid access (both mean = 1.43), reflecting a more critical stance likely shaped by their hands-on site experience. Consultants generally offered a middle-ground perspective, with mean scores between those of clients and contractors. For example,

in accident reporting, consultants rated the process at a mean of 1.96, lower than clients (2.12) but higher than contractors (1.5).

Despite these variations, there were some areas of agreement among all groups. The provision of PPE was seen as one of the most consistently implemented safety measures, receiving relatively high scores from all stakeholders. Conversely, the monitoring of air quality in confined spaces was seen as insufficient by all, with mean scores below 2.1, suggesting a shared concern for technical safety gaps.

Additionally, differences in standard deviations point to the level of consistency in perceptions. Clients showed higher variability (e.g., SD = 1.474 for mandatory training), possibly due to less direct involvement, while contractors had more consistent responses (e.g., SD = 0.742 for several items), likely due to their firsthand experience on-site. These findings reflect how stakeholder roles influence their views on safety implementation in sewerage projects.

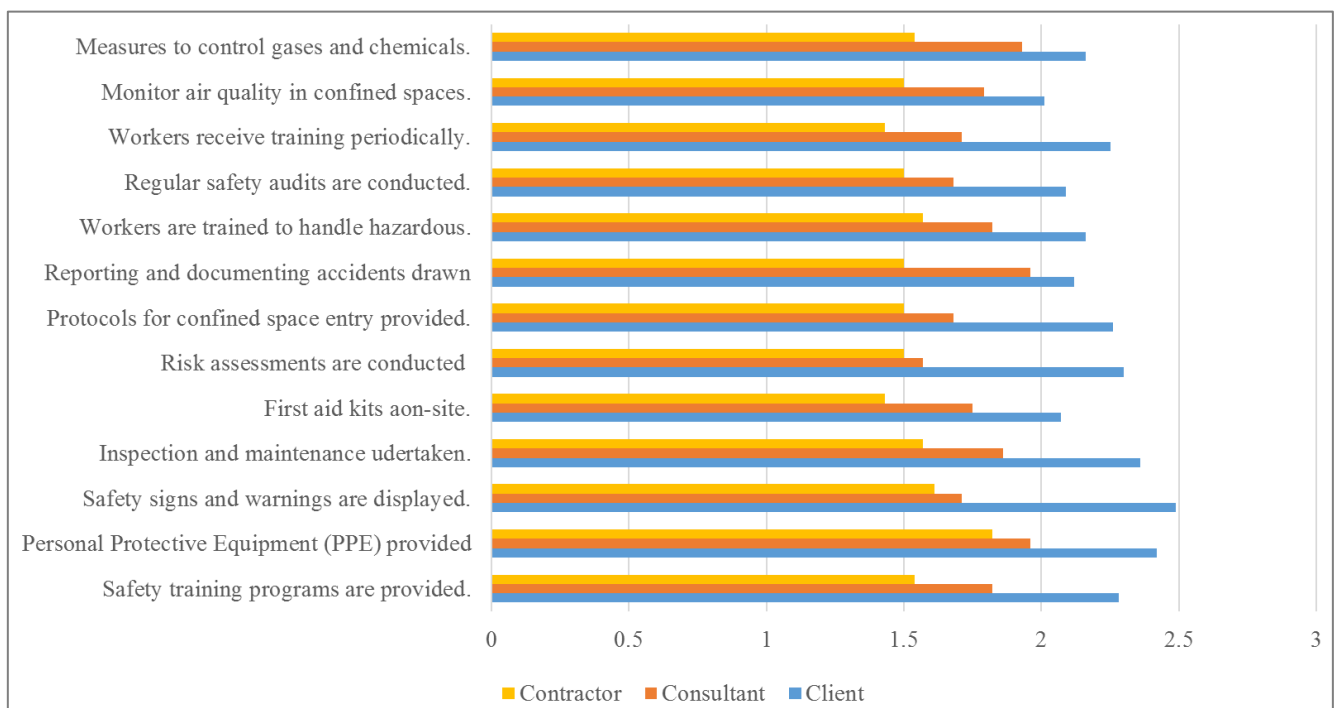


Figure 1. Perspectives of stakeholders on implemented safety practices.

The study reveals major gaps in safety training, PPE provision, and emergency preparedness in sewerage projects, putting workers at risk. Effective training is essential, as emphasized by [19, 20], who highlight the need for engaging, culturally aware safety programs. A lack of mandatory training has been linked to high injury rates in Ethiopia [21]. Similarly, PPE is insufficient, reflecting findings by [19]. While safety signs are present, adherence remains weak, contrasting with better compliance reported by [22]. Regular inspection and maintenance are also lacking, as noted by [23].

Finally, limited access to first aid and emergency care mirrors concerns raised by [24-26] about the importance of on-site medical readiness.

3.3. Health Hazards and Factors Posed by Sewerage Projects to Workers

The study highlights significant health risks faced by workers in sewerage projects, which include both physical and psychological hazards due to prolonged exposure to

hazardous conditions and inadequate preventive measures. Respiratory issues, particularly due to dust, chemicals, and poor sanitary conditions, are prevalent among workers, with 91.2% of respondents attributing these problems to their work environment. Exposure to toxic gases, particularly hydrogen sulfide (H₂S), and biological hazards like bacteria and viruses from sewage, also pose considerable risks. Additionally, workers face musculoskeletal disorders from heavy lifting and awkward postures, skin irritations from contact with polluted water, hearing loss due to noise exposure, and psychological stress caused by hazardous conditions. The study also reveals concerns about insufficient protection from extreme temperatures, inadequate protective gear, and the dangers of confined spaces. Moreover, most workers are not properly vaccinated against diseases like hepatitis and tetanus, further exacerbating health risks. The lack of adequate training to identify and address these hazards is another critical issue. Figure 2 compares stakeholder perceptions

of health risks in sewerage projects, revealing both shared concerns and notable differences. Contractors, due to their direct exposure to hazards, reported the highest mean scores on nearly all health risk factors, such as biological hazards and psychological stress (both mean = 4.57) with low standard deviations, indicating consistent and experience-based responses. In contrast, clients gave lower mean scores (e.g., 4.25 for both hazards), likely reflecting their administrative distance from on-site risks, and showed higher variability in responses. Consultants typically held middle-ground views, sometimes aligning more closely with either contractors or clients, such as in the case of heat illness (mean = 4.36) and health hazard training (mean = 4.14). Despite these differences, all stakeholders acknowledged serious health threats in sewerage work, with most hazard ratings exceeding a mean of 4.0, underscoring a shared recognition of dangers like respiratory issues, confined space risks, and musculoskeletal problems.

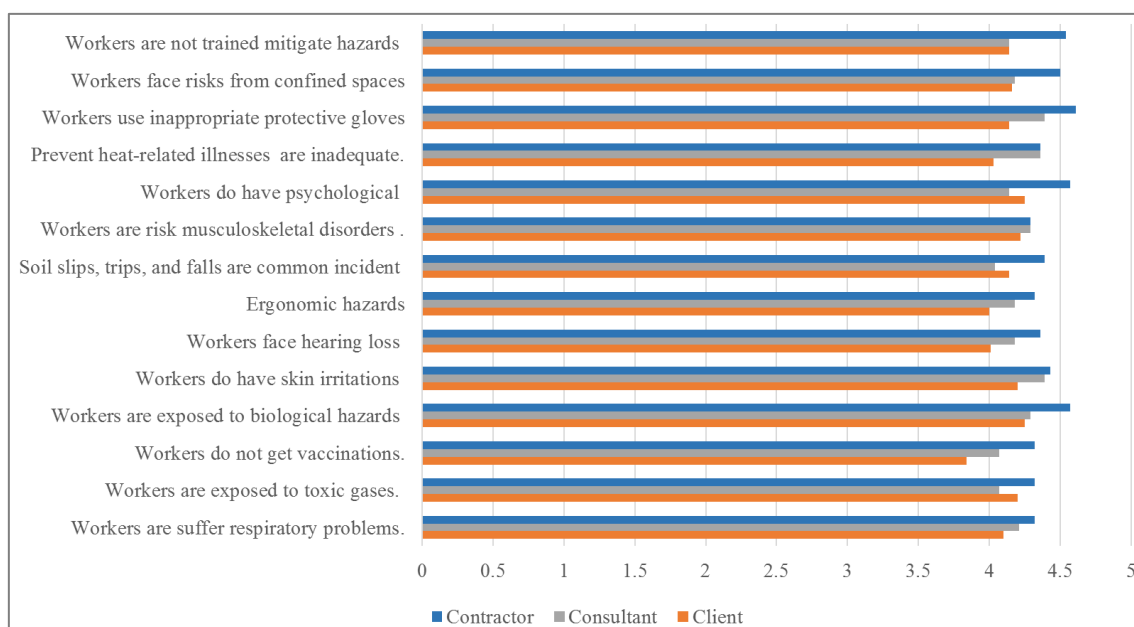


Figure 2. Outlook of stakeholders on health hazards in sewerage projects.

The findings on health hazards faced by sewage workers align with previous research across countries like Malaysia, Egypt, and India, which report high rates of respiratory ailments among workers [27-29]. Exposure to pathogens such as hepatitis viruses, E. coli, and Salmonella in sewage has been well-documented [30-33], with chronic infections more prevalent in exposed workers. Alarming, many workers lack immunization 96.5% in Karachi were unvaccinated for key diseases highlighting the urgent need for vaccination programs. Chemical hazards, including hydrogen sulfide and VOCs, pose additional risks, with links to reduced lung func-

tion and discomfort [34-36]. Moreover, the physically demanding nature of the job leads to musculoskeletal disorders due to repetitive strain and poor ergonomics [37, 38].

3.4. Strategies for Enhancing Safety Practices in Sewerage Projects in the City

The study investigated various strategies for improving safety practices in sewerage projects, with respondents ranking their effectiveness through a Relative Importance Index (RII).

Table 2. Strategy enhancing the safety of workers in sewerage projects.

Rank	Strategy for enhancing the safety of the worker
1	Quality Personal Protective Equipment (PPE) for workers.
2	Implementing advanced monitoring technologies (e.g., gas detectors, and air quality monitors)
3	Regular training programs for workers
4	Regular safety audits would enhance compliance.
5	Establishing a dedicated safety management team
6	Continuous monitoring and evaluation of safety practices.
7	Conducting community awareness programs
8	Engagement in behavior-based safety
9	Increasing worker involvement in safety planning
10	Implementing stricter safety regulations and enforcement
11	Increased collaboration with international safety organizations.

The highest-rated strategy was investing in higher-quality Personal Protective Equipment (PPE), with a mean score of 4.62 and an RII of 0.9248, reflecting its importance in reducing accidents, and health risks, and boosting worker morale. The second most effective strategy was the implementation of advanced monitoring technologies like gas detectors and air quality monitors, with an RII of 0.9216. This highlights the critical role of real-time environmental monitoring in preventing health hazards. The third strategy, regular safety training for workers, also received high marks (RII = 0.92), emphasizing the value of continuous education in promoting safe working practices. Other notable strategies included regular safety audits, the establishment of safety management teams, continuous monitoring and evaluation of safety practices, and involving the community in safety efforts. While the study found high support for increased collaboration with international safety organizations, this strategy was ranked the lowest but still had significant backing (RII = 0.8784). The study highlights a consensus on the importance of proactive measures, proper training, and robust safety equipment to reduce the health risks associated with sewerage work.

3.5. Summary of Findings

The findings of this study uncovered serious deficiencies in the implementation of safety protocols and practices within sewerage project sites. A significant majority of respondents reported that essential safety measures such as mandatory training, personal protective equipment (PPE), risk assessments, emergency medical provisions, and safety audits are either absent or poorly enforced. Specifically, over 75% indicated that workers do not receive safety training before commencing tasks, and similarly high percentages

noted the lack of PPE, safety signage, emergency services, and structured protocols for confined space entry. These lapses contribute to a work environment that is both hazardous and non-compliant with basic occupational safety standards. The perception of safety implementation varies among stakeholders, with clients often reporting more favorable conditions than contractors, who tend to express a more critical, firsthand view. Moreover, the study links these systemic failures to a range of health hazards faced by workers. High rates of respiratory issues, exposure to toxic gases, infections, hearing loss, musculoskeletal disorders, psychological stress, and environmental risks are all prevalent. The lack of preventive training, inadequate use of safety gear, and poor hazard control measures further compound these health threats. Overall, the findings underscore the urgent need for comprehensive safety reforms, including regular training, enforcement of PPE use, structured risk assessments, and improved emergency preparedness, to protect workers in the sewerage sector.

3.6. Conclusion

The results of this investigation demonstrate serious shortcomings in the use of safety procedures and practices in sewage projects. The data indicate a widespread lack of mandatory safety training, inadequate provision of personal protective equipment (PPE), insufficient hazard signage, and poor access to emergency medical services. Additionally, essential safety measures such as risk assessments, confined space entry procedures, and accident reporting mechanisms are either absent or poorly executed. Stakeholder perceptions, particularly those of contractors, highlight the disconnect between safety policy and on-ground realities, with contractors reporting the lowest levels of compliance across nearly

all indicators. These gaps not only violate basic occupational safety standards but also significantly elevate the risk of accidents, injuries, and long-term health issues for workers. Comparisons with previous research underscore the critical need for systemic improvements, including regular safety audits, comprehensive training programs that consider multicultural dynamics, and the enforcement of safety standards through routine inspections and emergency preparedness. The results call for immediate and coordinated actions from all stakeholders to establish a robust safety culture in sewerage project environments.

The findings of this study underscore the severe and multifaceted health hazards faced by workers involved in sewerage projects within the city. These hazards encompass respiratory illnesses, exposure to toxic gases such as hydrogen sulfide, biological threats from pathogens, and a host of physical and ergonomic risks, including musculoskeletal disorders, hearing loss, and injuries from slips or contact with sharp objects. The study also reveals significant gaps in preventive health measures, such as inadequate vaccination coverage and insufficient use of protective gear. Psychological stress and environmental factors like extreme temperatures and confined spaces risk further exacerbating the dangers. Notably, contractors, being the most exposed, reported the highest levels of concern, indicating a direct correlation between hazard perception and on-site experience. The consistency of these findings with global research highlights that these are not isolated issues, but rather systemic health and safety failures in the sanitation sector. There is a pressing need for comprehensive interventions, including improved training and stricter enforcement of occupational safety.

The study systematically evaluated various strategies for enhancing safety practices in sewerage projects, based on respondent feedback and quantitative analysis using the Relative Importance Index (RII). The results indicate that investing in higher-quality Personal Protective Equipment (PPE) emerged as the most critical safety strategy, reflecting the hazardous conditions faced by sewerage workers. This was closely followed by the implementation of advanced monitoring technologies and regular safety training, emphasizing the importance of proactive risk management and continuous education. Other notable strategies included regular safety audits, the establishment of a dedicated safety management team, and continuous safety evaluations, all aimed at reinforcing a culture of vigilance and accountability. Although ranked lower, strategies such as community involvement, behavior-based safety initiatives, worker participation in safety planning, and stricter enforcement of regulations were also recognized for their significant contributions. Even the lowest-ranked strategy, collaboration with international safety organizations received strong support, highlighting a broad consensus on the multifaceted approach needed to improve safety in sewerage projects. Collectively, these findings underscore the importance of integrating equipment, technology, training, and systemic oversight to effectively

mitigate risks and enhance worker safety.

3.7. Recommendations

Based on the results presented above the following recommendations were made:

- 1) The government should create a specialized regulatory system for the sewerage sector that enforces strict occupational health and safety standards, mandates high-quality PPE, regular health screenings, and clear employer responsibilities, along with penalties for non-compliance.
- 2) To reduce the risk of trench collapses, trench walls should be supported either by sloping (battering) or by using bracing systems like sheeting, especially in deep or unstable soil conditions.
- 3) Management and supervisors should regularly conduct safety audits, documentation, and site inspections to proactively identify and address hazards and ensure consistent safety practices.
- 4) Comprehensive training should be provided for workers, supervisors, and managers on hazard identification, PPE use, emergency responses, and first aid, ensuring better hazard mitigation and emergency preparedness.
- 5) Incorporate technologies such as gas detectors, air quality monitors, automated ventilation, remote monitoring tools, and digital checklists to improve safety and reduce human error, especially in confined or hazardous spaces.
- 6) Excavated materials should be kept at least one meter away from trench edges to prevent them from falling back in and causing injuries, wall pressure, or visibility issues.
- 7) Projects should include a safety team composed of trained professionals who oversee daily operations, focusing on enforcing health and safety standards and preventing risks.
- 8) Contractors must proactively plan, implement, and manage comprehensive health and safety programs through training, resource provision, regular monitoring, and reporting to protect workers, improve project outcomes, and promote overall community well-being.
- 9) Consultants must ensure workplace safety by integrating health and safety standards into contract documents, verifying worker training and safe conditions, supporting site management, and using safety as a key criterion during tendering.

Abbreviations

PPE	Personal Protective Equipment
RII	Relative Importance Index
SD	Standard Deviation
SPSS	Statistical Package for the Social Science
VOCs	Volatile Organic Compounds

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Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] A. K. Eyiah, N. A. Kheni, P. D. Quartey, An Assessment of Occupational Health and Safety Regulations in Ghana: A Study of the Construction Industry, *Journal of Building Construction and Planning Research* 07 (2019) 11-31. <https://doi.org/10.4236/jbcpr.2019.72002>
- [2] Sherif Mohamed, Safety climate in the construction site environments, *J Constr Eng Manag* 9364 (2002) 11.
- [3] MOWUD, Chilot Standard Conditions of Contract for Construction Of Civil Work Projects Ministry Of Works And Urban Development Standard Conditions Of Contract For Construction Of Civil Work Projects, (2007).
- [4] F. Tadesse, Jimma Institute of Technology School of Graduate Studies Faculty of Civil and Environmental Engineering Construction Engineering and Management Chair Assessment of Contractual and Legal Occupational Health & Safety Regulations Compliance on Public Buildin, (2020).
- [5] G. Hutton, L. Haller, J. Bartram, Global cost-benefit analysis of water supply and sanitation interventions, *J Water Health* 5 (2007) 481-501. <https://doi.org/10.2166/wh.2007.009>
- [6] WHO, UNEP, Safe use wastewater, excreta and greyewater. VOL1 policy and regulatory aspects, I (2006) 114.
- [7] Temesgen Mekuriaw Manderso, Overview of Existing Wastewater Management System in in Case of Debre Markos Town, Ethiopia., Science Publishing Group. 2 (2018) 107-118.
- [8] OMS, Guidelines On Sanitation and Health., 2018. http://www.who.int/water_sanitation_health/publications/guidelines-on-sanitation-and-health/en/
- [9] R. R. Tiwari, Occupational health hazards in sewage and sanitary workers, (2014). <https://doi.org/10.4103/0019-5278.44691>
- [10] L. Forst, L. Nickels, L. Conroy, The WHO modules in occupational safety and health: training for prevention., *Public Health Rep* 124 (2009) 169-176. <https://doi.org/10.1177/003335490912400122>
- [11] P. Taylor, A. E. Dembe, J. B. Erickson, R. Delbos, A. E. Dembe, J. B. Erickson, R. Delbos, Predictors of Work-Related Injuries and Illnesses : National Survey Findings, (2010) 37-41. <https://doi.org/10.1080/15459620490478376>
- [12] B. Hunegnaw, M. Molla, Y. Mulugeta, M. Meseret, Assessment of occupational injury among industrial workers in the Bahir Dar city of northwest Ethiopia: Institution-based cross-sectional study, *J Environ Public Health* 2021 (2021). <https://doi.org/10.1155/2021/2793053>
- [13] United Nations, SDG6 Synthesis Report 2018, 2018. https://www.unwater.org/publication_categories/sdg-6-synthesis-report-2018-on-water-and-sanitation/
- [14] Lucy Fekele, Prof. Emer T. Quezon, Yolente C. Macarubbo, Evaluation of Health and Safety Practice in Building Construction: A Case Study in Addis Ababa, *Int J Sci Eng Res* 7 (2016) 122-131.
- [15] D. Podgórski, ILO Guidelines on Occupational Safety and Health Management Systems, 2021. <https://doi.org/10.1201/9780429189890-33>
- [16] W. S. Tesfaye, Assement of Workers Safety Practice in Public Building Construction Projects : in the Case of Addis Ababa Construction Office Projects Master of Engineering Addis Ababa Science and Technology, (2017) 132.
- [17] S. Abebe, Assessment of Safety Measures on Construction Projects : The Case of Arba Minch University Projects, (2022).
- [18] S. Al-Amad, Responsible Conduct of Research, 2017. https://doi.org/10.1007/978-3-319-65266-5_35
- [19] J. Yeboah Siaw, Occupational Health and Safety Status in the Management of Faecal Sludge in Ghana: A Case Study of the Lavender Hill Faecal Treatment Plant, *Journal of Health and Environmental Research* 4 (2018) 42. <https://doi.org/10.11648/j.jher.20180402.11>
- [20] J. Goh, S. Zenios, The Relationship Between Workplace Stressors and Mortality and Health Costs in the United States, *Manage Sci* 62 (2015) 150313065100000. <https://doi.org/10.1287/mnsc.2014.2115>
- [21] Y. M. Alamneh, A. Z. Wondifraw, A. Negesse, A. Negesse, D. B. Ketema, T. Y. Akalu, The prevalence of occupational injury and its associated factors in Ethiopia: A systematic review and meta-analysis, *Journal of Occupational Medicine and Toxicology* 15 (2020) 1-11. <https://doi.org/10.1186/s12995-020-00265-0>
- [22] H. Ngah, S. M. Hairon, N. A. Hamzah, S. Noordin, M. N. Shafei, Assessment of Knowledge, Attitude, and Practice on Safe Working in Confined Space among Male Water Services Workers in the Central Region of Malaysia, *Int J Environ Res Public Health* 19 (2022). <https://doi.org/10.3390/ijerph19127416>
- [23] D. Obradović, M. Šperac, S. Marenjak, Challenges in Sewer System Maintenance, (2023) 122-142.
- [24] M. Khairi, B. I. N. Anuar, Centre of Studies for Building Surveying Faculty of Architecture, Planning and Surveying Public Perception of Intelligent Building in Malaysia Case Study of Klang Valley Bachelor of Building Surveying (Hons), (2015).

- [25] L. O. Adebisi, R., Yusuf, G. A., Rasheed, A. S., & Olorunjo, View of Health and Safety Information Management on Construction Sites in Lagos State, Nigeria. pdf, (2024).
- [26] G. K. Aswed, H. A. Mohammed, M. N. Ahmed, Factors affecting safety in construction projects, *International Review of Civil Engineering* 11 (2020) 135-140. <https://doi.org/10.15866/irece.v11i3.17142>
- [27] M. Misnan, Best Practice of Reporting Accident and Safety, 22 (2024) 90-103.
- [28] O. Hassan, A. H, A. E, F. N, Adverse Dermatologic and Respiratory Health Problems Among Street Sweeper's Workers: a Comparative Study, *Egypt J Occup Med* 43 (2019) 111-127. <https://doi.org/10.21608/ejom.2019.25126>
- [29] P. A. Giri, A. M. Kasbe, R. Y. Aras, A Study on Morbidity Profile of Sewage Workers in Mumbai City, *Aras RY International Journal of Collaborative Research on Internal Medicine & Public Health* 2 (2010) 0. <http://www.iomcworld.com/ijcrimph/>
- [30] R. A. Helal F., Some Biological Health Hazards Among Sewage Workers, *Egypt J Occup Med* 33 (2009) 119-130. <https://doi.org/10.21608/ejom.2009.673>
- [31] A. Yajima, T. Koottatep, Assessment of *E. coli* and *Salmonella* spp. infection risks associated with different fecal sludge disposal practices in Thailand, *J Water Health* 8 (2010) 355-364. <https://doi.org/10.2166/wh.2009.310>
- [32] W. Zieliński, E. Korzeniewska, M. Harnisz, J. Hubeny, M. Buta, D. Rolbiecki, The prevalence of drug-resistant and virulent *Staphylococcus* spp. in a municipal wastewater treatment plant and their spread in the environment, *Environ Int* 143 (2020). <https://doi.org/10.1016/j.envint.2020.105914>
- [33] M. Kowalski, J. Wolany, J. S. Pastuszka, G. Plaza, A. Wlazło, K. Ulfing, A. Malina, Characteristics of airborne bacteria and fungi in some Polish wastewater treatment plants, *International Journal of Environmental Science and Technology* 14 (2017) 2181-2192. <https://doi.org/10.1007/s13762-017-1314-2>
- [34] K. K. Heldal, Å. D. Austigard, K. H. Svendsen, E. Einarsdottir, L. O. Goffeng, L. I. Sikkeland, K.-C. Nordby, Endotoxin and Hydrogen Sulphide Exposure and Effects on the Airways Among Waste Water Workers in Sewage Treatment Plants and Sewer Net System., *Ann Work Expo Health* 63 (2019) 437-447. <https://doi.org/10.1093/annweh/wxz020>
- [35] H. Byliński, J. Gębicki, J. Namieśnik, Evaluation of health hazard due to emission of volatile organic compounds from various processing units of wastewater treatment plant, *Int J Environ Res Public Health* 16 (2019). <https://doi.org/10.3390/ijerph16101712>
- [36] A. Saleh, R. El lassy, A. Madian, Prevalence and Determinants of Occupational Health Hazards among Sewage Workers in EL-Beheira Governorate, *Damanhour Scientific Nursing Journal* 1 (2023) 66-84. <https://doi.org/10.21608/dsnj.2023.337872>
- [37] A. Jaiswal, Sewage Work and Occupational Health Hazards: An Anthropological Insight, *Archaeology & Anthropology: Open Access* 2 (2018) 211-217. <https://doi.org/10.31031/aaoa.2018.02.000538>
- [38] A. B. Pitamber Subedi, Knowledge and Preventive Practices among Construction Workers work in KTFT Project Regarding Occupational Health Hazards and Safety: A Descriptive Cross-Sectional Study, (2024).