

Impact of Noise Pollution at Construction Sites of Sindh Pakistan

Haseeb Haleem Shaikh^{1*}, *Noor Yasmin Zainun*¹, and *Shabir Hussain Khahro*²

¹Jamilus Research Center, Faculty of Civil Engineering & Environmental Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor

²Department of Engineering Management, Prince Sultan University, Riyadh, KSA

Abstract. Noise pollution refers to the excessive and unnecessary intensity of sound that can pose harmful or dangerous effects on humans and the surrounding ecosystem. Unfortunately, the occurrence of noise pollution is worsening because of ongoing country development. Construction sites have emerged as significant contributors to noise pollution in urban areas, as the continuous development and construction projects necessitate high levels of noise. This research conducts a study on Sindh construction projects because the government of Sindh is involved in constructing mega projects. The presence of noise pollution at construction sites poses a significant health risk to individuals involved in construction projects and those who spend extended periods of time at these sites. Therefore, the primary goals of this study are to identify the factors contributing to noise pollution at construction sites and examine the impact of this noise on various parties such as engineers, contractors, and others. Additionally, this study aims to propose solutions to mitigate and reduce noise pollution at construction sites to minimize its negative effects. This study designs the questionnaire survey form and collects the data from 94 respondents working in Sindh construction sectors to identify the most significant factors that impact and solution for minimizing noise pollution on construction sites. The received data were analyzed through average index technique to achieve the results. Based on results the significant factors impact on construction site was operating of heavy machineries that effect on construction workers and surrounding residences during sleeping disturbance. This study suggested that construction stakeholders should take necessary precautions to reduce noise pollution.

1 Introduction

Construction industry is one of the major sectors and plays an important role in increasing the GDP of countries by providing thousands of job opportunities. Construction sector linked with many sectors to developed countries as well as cities. During construction, noise pollution significantly impacts the public, and residents, disrupting daily activities in proximity. The widespread construction activities generate noise pollution, which is

* Corresponding author : shkhahro@psu.edu.sa

necessary for development. Construction work emerges as a major source of long-term noise pollution, characterized by a combination of various sounds [1]. Construction workers were highly affected by noise pollution due to long working hours that impacted on their health. Due to noise pollution, 16% of workers from worldwide was disable – hearing loss that was big challenge for stakeholders [2]. Noise pollution at construction sites is caused by various factors, such as the noise generated by machinery, handwork construction activities like piling, welding, knocking, hammering, and material transportation. The level of noise at a construction site varies depending on the type and stage of the work being carried out. Each job requires different equipment or instruments, resulting in a mixture of different types of noise[3]. Another study indicates that the impact of noise pollution on construction workers is greater than on the general public or nearby residents[4]. This has put over half a million workers at risk of dangerous exposure. However, the Occupational Safety & Health Administration (OSHA) programs provide limited incentives to protect workers from noise-induced hearing loss[5].

Mostly construction worker and labours are forced for completion of task even in a bad weather condition by doing working for long hours than normal hours under the hot weather, having high sounds of machineries working at construction sites and having dust on site affect their mental health. Doing a job under the sun and having a high level of noise pollution puts the construction workers in high stress[6]. Stress is the serious problem that cause cardiovascular disease and other factors that increase stress was noise pollution[7]. Construction worker and surrounding residents was highly affected by construction activities carried out with heavy machineries that creates high level of noise pollution cause mentally disturbance, inconvenience in sleeping, cardiovascular disease, frustration, and chance loss of hearing[8].

Therefore, this study determined the factors contributing to noise pollution at construction sites of Sindh Pakistan and examined the impact of noise from various parties to minimize with solution.

2 Research methodology

Detail literature review has been carried out by previous studies that has been published by researchers around the world. During reviewing this study identified the factors that cause noise pollution that affect health of construction workers as well as surrounding individuals.

This research aims to identify the factors that cause for noise pollution at construction sites, factors that impact of noise pollution on workers' health, and recommend mitigations for noise pollution at construction sites of Sindh Pakistan. Therefore, the population of this research was 3C companies (client, contractor, and consultant) working around Sindh.

These identified factors have been transferred into questionnaire survey forms. The survey form was sent to employees working on construction projects of Sindh Pakistan. The received survey forms were analysed through the Average index method to determine the significant factors that cause for noise pollution on construction sites and impacting on health workers. Once the data has been analysed, it is important to determine recommendations based on the findings. In the case of noise pollution, conclusions regarding the factors, effects, and potential solutions should be identified and recorded in a report for future reference and further studies.

3 Data collection and analysis

The questionnaire survey forms sent to respondents working with different sectors such as Contractor, Consultants and Client. A total of 125 survey forms were distributed among the

respondents that had been working at different levels. A total of 94 forms were received and data has been analysed through average index method to identify the factors that cause for noise pollution.

According to [9], if number of chosen respondents/population in between 120 – 130, so therefore sample size should be in between 92 – 97. This research successfully achieved 94 filled survey forms to meet the requirements.

$$AI = \frac{\sum (1X1 + 2X2 + 3X3 + 4X4 + 5X5)}{\sum (X1 + X2 + X3 + X4 + X5)} \tag{1}$$

Where;

- X1 = Number of respondents for scale 1
- X2 = Number of respondents for scale 2
- X3 = Number of respondents for scale 3
- X4 = Number of respondents for scale 4
- X5 = Number of respondents for scale 5

Evaluation ranges

- 1.00 < AI < 1.50: Not Significant (NS);
- 1.50 < AI < 2.50: Slightly Significant (SS);
- 2.50 < AI < 3.50: Moderately significant (MS);
- 3.50 < AI < 4.50: Very Significant (VS);
- 4.50 < AI < 5.00: Extremely Significant (ES)

4 Results and Discussion

The results and discussion are based on data analysed through average index. This study considered the significant factors and mitigation/solution evaluation range values should be 3.5 or more, suitable for acceptance. Table 1 shows significant factors that cause noise pollution and mitigation.

Table 1 shows the results that major respondents agreed and identified the factors and suggested mitigations to control over noise pollution at construction sites. Based on the results heavy machineries observed significant factors followed by construction equipment, transportation vehicles and communication in high voices was cause for noise pollution at construction sites. The cardiovascular disease, sleeping disturbance and hearing issues highly impact on workers’ health that stakeholders should take notice and act on it. Many respondents working with different sectors agreed that to control the noise pollution at construction site stakeholders must change old equipment with new one, placing of noise barrier around the sites, and using of PPE (personal protective equipment) normally.

Table 1. Factors caused by noise pollution and mitigation.

Factor	Client	Consultant	Contractor
Cause for Noise Pollution at Construction Site			
Heavy machineries	4.87	4.73	4.69
Construction Equipment	4.53	4.11	4.80
Transportation vehicles	3.97	3.60	4.11
Communication in high voice	3.89	4.54	4.01
Impact of Noise pollution on health			
Cardiovascular Disease	4.63	4.91	4.10
Sleeping disturbance	4.21	4.13	3.87
Hearing issues	3.66	3.60	3.51
Mitigation for noise pollution at construction sites			
Changing of old Equipment with new equipment	4.77	4.89	3.97
Place noise barrier around constructions sites	4.56	4.66	3.65
Strictly using of PPE	4.17	4.23	3.59

4.1 Cause for Noise Pollution at Construction Sites

Four factors were identified that cause noise pollution at construction sites, which was usage of heavy machinery, types of construction equipment's such as welding, knocking, and hammering, transportation vehicles, and communication in high voices. Maximum number of respondents/stakeholders agreed that operating heavy machinery causes mostly noise pollution at construction sites.

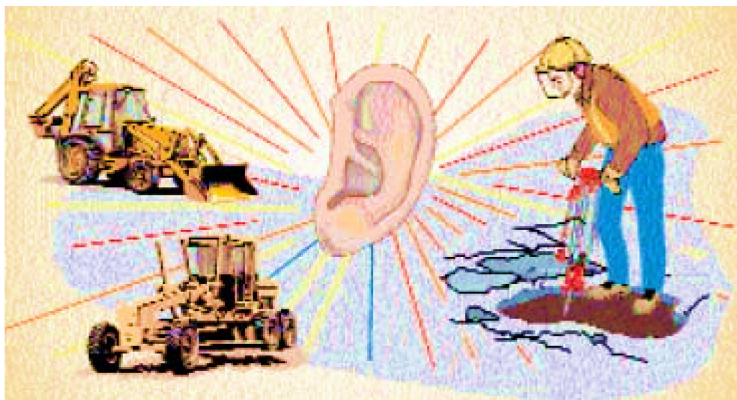


Fig. 1. Heavy machinery [10]

Figure 1 shows the type of heavy machinery that causes noise pollution at construction sites because of high intensity of sounds. This study examined various types of construction equipment, including asphalt pavers, backhoes, bulldozers, compaction equipment, excavators, haul trucks, telehandlers, and wheeled loaders. The findings indicated that operators of bulldozers consistently experienced the highest levels of noise exposure. These exposures ranged from 844% to 25,836% of the NIOSH REL (Recommended Exposure Limit) dose and from 139% to 1,397% of the OSHA PEL (Permissible Exposure Limit) dose[11]. The second most cause was construction equipment's such as welding and hammering that impact the construction worker on site.



Fig. 2. Construction equipment, transportation vehicles and communication in high voice. [12], [13]

Figure 2 shows different construction equipment's, transportation vehicles and communication in high voice was observed major cause for noise pollution at construction sites. Noise pollution on construction sites cause by welding and hammering in high intensity of sound will cause harmful or danger towards human or nearby ecosystem. Construction equipment was highly used on construction sites and continuously using construction equipment by labor had a negative impact on their health. It is crucial to prioritize the safety and comfort of construction workers by providing them with appropriate hearing protection at work. Additionally, it is essential to ensure that employees receive sufficient training on

the proper use of hearing protection equipment[14]. The third factor that causes noise pollution was frequent transportation of material at project sites. The level of noise pollution in transport systems has become increasingly concerning over the years, necessitating the need for research and control measures to prevent various health issues such as high blood pressure, insomnia, nausea, heart attacks, depression, dizziness, headaches, and hearing loss. To control noise, different techniques and equipment should be used according to the situation and requirement. In industries, ear plugs and mufflers shall be used. It is necessary to work on reducing the vehicular sources of noise by developing low noise producing automobile vehicles, aircrafts and ships [13]. The fourth factor causing noise pollution was communication in high volume. It has been observed that on construction projects mostly employees communicate in loud voice that impact on labor productivity. There should be controlled on communication between the workers and provide every labor to discuss and raise their issues in polite way[15].

4.2 Impact of noise pollution on health

Three factors identified that cause noise pollution on health were cardiovascular disease, sleeping disturbance, and hearing issues. Maximum number of respondent/stakeholders agreed that cardiovascular disease highly impact on worker health on construction sites.



Fig. 3. Cardiovascular disease, sleeping disorder and hearing issues. [16], [17], [18]

Figure 3 shows symptoms of cardiovascular disease, symptoms of work sleep disorder and hearing problems due to certain causes. The main cause of cardiovascular disease is stress and that stress has been create by noise pollution [19]. Continuous high levels of noise can impact stress hormones like noradrenaline, adrenaline, and cortisol. Activities that cause disturbances, such as construction work, can also lead to stress, both directly and indirectly. The management should provide realistic deadlines, avoid overburden, encourage employees with benefits and bonuses. The second impact on noise pollution was sleeping disturbance. The overall health and quality of life of workers greatly depend on their sleep health. Workers who suffer from sleep disorders encounter a range of physical and mental health issues, such as abnormal vital signs, mood disorders, diminished quality of life, increased workplace injuries, and even premature mortality[20]. There is a strong connection between sleep issues and mental well-being. Disruptions in sleep patterns have been found to be linked to detrimental psychological symptoms like depression and anxiety[21]. The third impact on noise pollution was hearing issues. The hearing issue has emerged as a significant occupational disease among construction workers. Ear-related disorders can have various impacts on their ability to perform work effectively. Common problems include hearing difficulties, tinnitus, ear discharge, posture disturbances, and other auditory disorders. These issues, particularly noise-induced hearing loss (NIHL), have become prevalent across the industry[22].

4.3 Mitigation for noise pollution at construction sites

The first mitigation to control noise pollution on construction sites was changing of old equipment with new equipment. It has been observed that mostly contractors used old equipment that makes noise pollution around the construction site. The replacement of new equipment with old equipment affects the contractor's costs and profit. To make informed decisions about equipment replacement, equipment managers must accurately forecast the resale value of the equipment within an acceptable range to control on noise pollution[23]. The second mitigation to control noise pollution on construction sites was placing noise barrier around constructions sites. Active noise control is being applied to barriers in construction sites to protect the street area and neighboring buildings from construction noise activities, thereby increasing their use as a means of protection for pedestrians and nearby structures[24]. The third mitigation to control noise pollution was using of PPE (Personnel Protective Equipment's). Workers are typically provided with earplugs as a form of personal protective equipment (PPE) to minimize their exposure to noise. Earplugs should be considered as the final option for controlling noise and should only be given when other methods of noise control are not feasible. In general, workers should use earplugs whenever they are exposed to noise levels of 85 dB(A) or when they need to raise their voices to communicate[25].

5 Conclusion

Noise pollution is inevitable in developing countries or areas, and it can have various effects on workers and residents nearby. Identifying the primary factor contributing to noise pollution at construction sites is crucial for implementing effective prevention measures. The most significant factor is the operation of heavy machinery, which generates high-frequency noise. The most notable consequence of noise pollution is sleeping disturbance, as the continuous operation of machinery prevents workers and residents from resting properly. Therefore, the replacement of new equipment's with old one should be considered, with the installation of silencers or mufflers on machinery is the most effective solution to address the issue. By equipping the machinery with silencers or mufflers, the frequency of noise produced can be greatly reduced, allowing nearby workers and residents to have a more peaceful rest.

6 Recommendations

Following are some recommendations that stakeholder shall consider controlling of noise pollution at construction sites. Controlling noise pollution at construction sites is important to protect the health and well-being of workers and nearby residents. Here are some precautionary measures and control methods that can be implemented to minimize noise pollution:

- i. Use noise control measures
 - a) Use noise control equipment and machinery that are designed to reduce noise emissions. For example, choose construction equipment with built-in noise reduction features.
 - b) Implement noise barriers and soundproof enclosures around noisy machinery or construction activities to contain the noise.
 - c) Install mufflers and silencers on equipment and vehicles to reduce noise levels.
- ii. Schedule and planning

- a) Plan construction activities in a way that minimizes noise during sensitive times, such as early mornings, late evenings, and weekends.
 - b) Coordinate with local authorities and neighboring communities to establish construction hours that are acceptable to all parties involved.
 - c) Plan noisy activities away from residential areas, if possible.
- iii. Training and education
- a) Provide training to construction workers on the importance of noise control and the proper use of noise-reducing equipment.
 - b) Promote awareness among workers about the potential health hazards of excessive noise exposure and the importance of using personal protective equipment (PPE) such as earplugs or earmuffs.
- iv. Regular equipment maintenance
- a) Conduct regular maintenance and inspections of construction equipment to ensure that noise-reducing features are functioning properly.
 - b) Repair or replace any machinery or equipment that is producing excessive noise.
- v. Communication and community engagement
- a) Maintain open communication with nearby residents and communities to address their concerns regarding noise pollution.
 - b) Inform them in advance about construction activities that may generate high levels of noise and provide updates on progress and mitigation efforts.
- vi. Compliance with regulations
- a) Follow local, state, and national regulations and guidelines regarding noise pollution control at construction sites.
 - b) Regularly monitor noise levels at the construction site to ensure compliance with the set standards.

Implementing these precautionary measures and control methods can help minimize noise pollution at construction sites and create a safer and healthier environment for workers and nearby communities.

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