Proceedings of the 3rd International Conference on Civil Engineering for Sustainable Development (ICCESD 2016), 12~14 February 2016, KUET, Khulna, Bangladesh (ISBN: 978-984-34-0265-3)

IMPACT ASSESSMENT OF RAIL INDUCED NOISE IN DHAKA CITY

N. Anwari*[1] and M. S. Hoque[2]

[1]*Student, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: nafisanwari@yahoo.com*
[2]*Professor, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: shamhoque84@gmail.com*

ABSTRACT

So far no comprehensive study has been conducted to assess the impact of noise generated by frequent train movements on people living nearby railway tracks. This study is focused on assessing people's perception on noise-induced stress who are living in and doing business along the Dhaka-Tongi railway corridor. Questionnaire surveys were conducted at Banani, Kamalapur, Khilgaon, Malibag, Moghbazar, Siddeswari and Shahjahanpur to evaluate the present scenario of noise pollution due to train movements. Considering the inherent differences in characteristics, preferences and opinions, the respondents were divided into residential people and job holder groups. From the survey, it is worrying to note that 19% of the respondents are not aware of the consequences of noise pollution, even though most people have become accustomed with the high level of noise. The 33% participants at home feel rail induced noise is most painful at night while 60% participants in office consider the noise to be unbearable in the morning. Evaluation of the health impact revealed that a shocking 44% residential people find it difficult to sleep while 31% people cannot concentrate at work because of headaches. Welfare loss and effect of noise on children's study and on heart patients are also examined. A quantitative noise assessment survey to validate the questionnaire survey results alarmingly revealed noise levels to be significantly higher than accepted standards. The assessment emphasized that the people's health hazard issues need immediate attention by the relevant authorities and effective noise attenuation measures need to be undertaken to reduce the degree of exposure.

Keywords: *Health impact; noise assessment survey*

1. INTRODUCTION

Sound annoyance is a "feeling of displeasure associated with any agent or condition related to sound that is believed to affect adversely an individual or group". The noise from whistle at level crossing and when trains travel is a significant source of sound annoyance in rail line. Noise health effects are the health consequences of elevated sound levels. Elevated workplace or other noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance and sleep disturbance (Vallet et al., 1983, Health Council of Netherlands, 1996, Horne et al., 1994). Changes in the immune system and birth defects have been attributed to noise exposure. Although some presbycusis may occur naturally with age, in many developed nations the cumulative impact of noise is sufficient to impair the hearing of a large fraction of the population over the course of a lifetime. Noise exposure has also been known to induce tinnitus, hypertension, vasoconstriction and other cardiovascular impacts (Health Council of Netherlands, 1996). Beyond these effects, elevated noise levels can create stress, increased workplace accident rates, and stimulate aggression and other anti-social behavior (Topf, 1988, Goines & Hagler, 2007). As a result, one of the first reactions of people who live or work in the vicinity is about the noise and about the quality of the environment around their home or office. Besides, the impact on other noise sensitive buildings, such as hospitals, schools, homes for the handicapped and homes for the elderly people, has to be considered. Hence, it is now imperative to assess the impact of rail induced noise on human beings. So far, no inclusive study to examine such effects has been undertaken in Dhaka city. Thus, the affected people and concerned authority remain largely ignorant of the type and extent of physical and mental distresses experienced. In light of this situation, a questionnaire survey was conducted to assess person-related factors influencing noise annoyance, namely physiological, psychological and social factors that affect the perception of noise and impair activities. The questionnaire survey was prepared to understand the range and extent of problems faced by people living and working beside or close to the rail line. The results of this survey are then collaborated with noise level readings taken at survey locations, which are then compared with prescribed noise limits set by the Department of Environment (DOE).

2. METHODOLOGY OF QUESTIONNAIRE SURVEY AND STUDY AREA

An observation survey was first carried out to identify potential places of work and residence affected by rail noise. Observation from reconnaissance survey of the at-grade railway line running through Dhaka city revealed that the areas most critically affected by rail induced noises include Banani, Kamalapur, Khilgaon, Malibag, Moghbazar, Siddeswari and Shahjahanpur. Afterwards, the questionnaire survey was carried out in each of the identified places. Considering the inherent differences in characteristics, preferences and opinions, the respondents were divided into residential people and job holder groups. People living in residences comprised of those living in buildings and slums. People working included those working in office buildings, shops or as day-labourers. The questionnaire survey was conducted between 1 February 2015 to 30 April 2015.

It was initially required to precisely determine the population covered by this survey, because the success of the conducted survey depends on obtaining a representative sample. The thesis paper covered an area having approximately 15,000 noise affected people combined for studying people in residential and commercial areas. It is ideal to take the representative sample as 10% of the total affected people, meaning, 1500 people needed to be surveyed. However, numerous problems encountered during surveying, combined with lack of concern and improper response of people regarding this survey made it difficult to obtain accurate opinion. Hence, round figures of 500 residential people and 500 job-holders were considered for the survey. The considered people are those who live within 25 metres of the railway line. This was done so that survey data reflects the real circumstances faced by people.

Before undertaking the formal main survey a pilot survey was conducted on 50 respondents to identify deficiencies in questionnaire design and any other problems that might have arisen on the field environment. Pilot sample survey revealed that a few questions were unclear to the respondents while a few other questions were found to be irrelevant for them. Besides, review of literature related to survey methods helped the author in refining the questions further. Accordingly, based on pilot survey, a total of 15 nos. questions were set for the final survey. Moreover, considering the fact that some questions relevant to the residential people did not apply to job-holders, a separate questionnaire was designed for two groups of respodents.

Some of the studied locations, namely Moghbazar and Malibag, were found to be densely populated with slums along the rail-line. Experiences during the conduct of the survey revealed many of the inhabitants to be too illiterate to answer coherently on their own. Hence the author questioned the slum dwellers orally and recorded on paper the oral feedback. People in other locations of interest were erudite enough to respond in writing without requiring external support.

3. RESULTS OF THE SURVEY

3.1 Population Distribution of Respondents

The population distribution of the respondents is provided in the following pie chart.

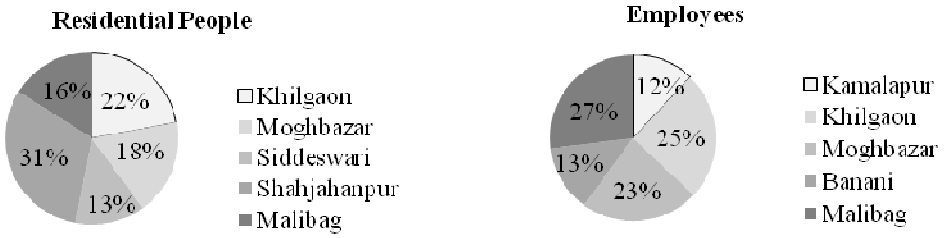

Figure 1: Population Distribution of Participants

The pie chart reveals that majority (31%) of the respondents are from Shahjahanpur, while the smallest share of respondents (13%) live in Siddeswari. For the questionnaire regarding service holders, the biggest share of respondents (27%) works in Malibag, while the smallest share (12%) is employed in Kamalapur.

Since rail noise attenuates with distance from rail line, it is important to determine the population distribution of the respondents, as shown in the following charts. In order to mitigate the impact of noise on their lives, people generally prefer to live and work further from the railway line, as evidenced by figure 2. It is seen that a

maximum of 29% people live around 10 to 15 metres from rail line, while 29% people work at 20 to 25 metres from rail tracks. 12% of the people live at less than 5 metres from the rail line. These are mainly poor slum dwellers who have no alternative. 8% of the people work within 5 metres from rail line. These people work in a variety of shops, which comprises mainly of tea-stalls and metal works.

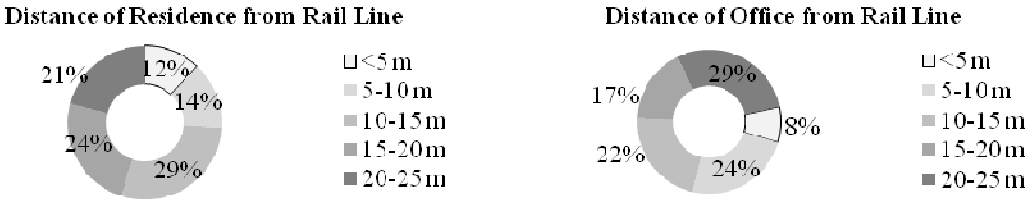

Figure 2: Population Distribution from Rail Line

3.2 Duration of Living or Working in Affected Place

Recognizing the need to understand the degree of temporal exposure to noise pollution, the following charts have been prepared to understand how long people have been living or working in the affected places.

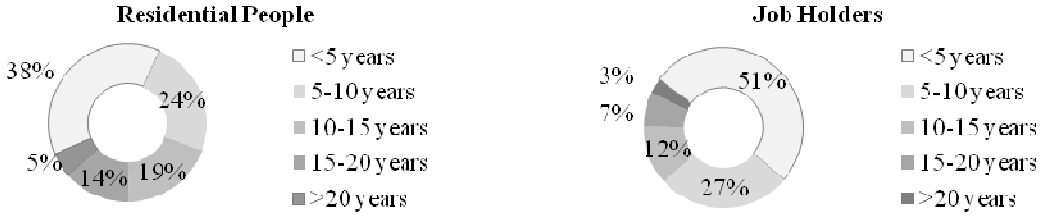

Figure 3: Duration of Living or Working in Affected Place

Figure 3 shows that majority of the people came to live or work in the respective places within the last five years. 5% of the respondents have been residing for more than 20 years, while 3% respondents have been working in the same place within the same period. These people are the worst affected of all the respondents, as they have been exposed to noise pollution for longest time. On the other hand, it is also true that people's reactions change over time. They might get accustomed to the noise.

3.3 Respondents Perception Regarding Noise Pollution

In order to assess noise induced health hazard,it is important to understand the level of awareness of the people regarding the impact of noise pollution.

Perception About Noise Pollution

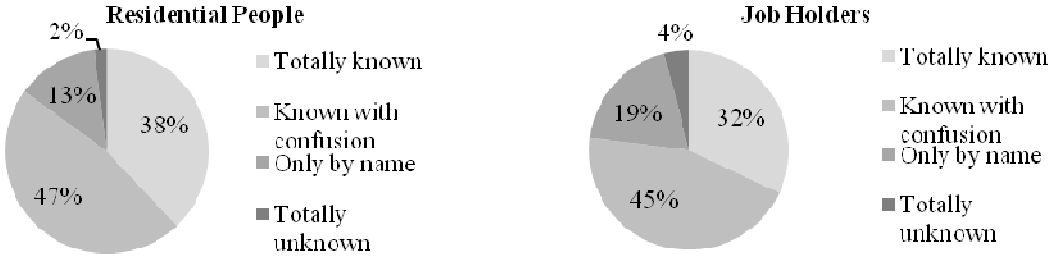

Figure 4: Percentage of People Aware of Noise Pollution

From Figure 4, it is alarming to note that 15% of the residential people and 23% of job holders have no clear understading about the impact of noise pollution. On average, 19% of the respondents are not totally aware of the health hazardcaused by noise. Which essentially suggests that the noise is a silent attacker to them. On the

other hand, it is encouraging to note that 35% of all respondents are well aware about the effects of noise pollution and also know about the protection required from such pollution.

3.4 Analysis of Questionnaire Survey

The alterations in people's feelings over time regarding noise pollution are illustrated in the following charts.

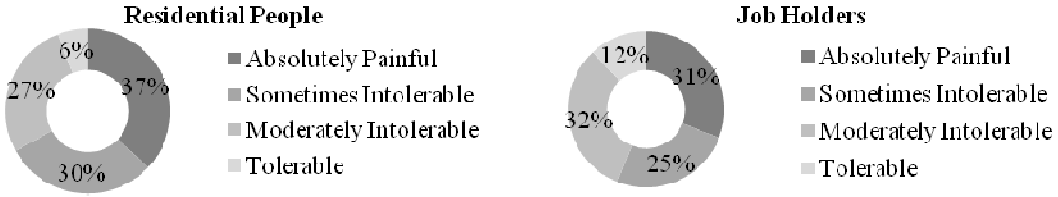

Figure 5: Feelings When Respondents were Initially Exposed to Noise Pollution

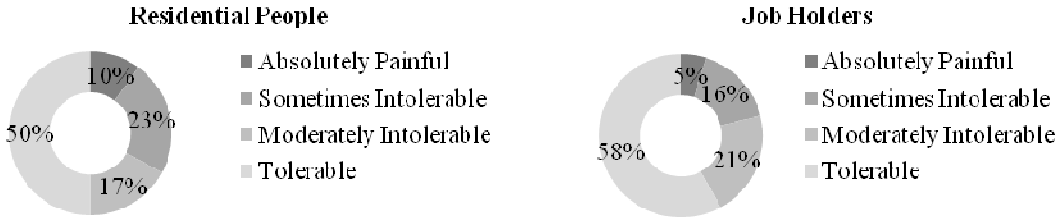

Figure 6: Present feelings regarding Noise Pollution

From Figures 5 and 6, it is observed that people had more difficulties in tolerating sound when they first moved to the area, compared to now. 37% of the residential people and 31% of the job holders felt they could not tolerate the noise at all initially. Another 23% residential people and 16% job holders had difficulty only when sound levels were at their worst, as shown in later charts. Only 6% of residential people and 12% of job holders had felt comfortable with the noise initially.

At present, situation has improved, since 50% and 58% of residential and job holders have respectively adjusted to the noise. However, this noise resistance may just be due to reduced hearing capacity among the affected people. On the other hand, it is disconcerting that more than 5% of the people in each group have not developed any resistance to sound pollution yet.

It is necessary to understand how many times people feel disturbed or annoyed per day, hence it is required to know the number of trains passing daily by the residential areas. The following chart represents people's perception on the number of trains passing through the areas.

People's Perception on How Often Trains Pass

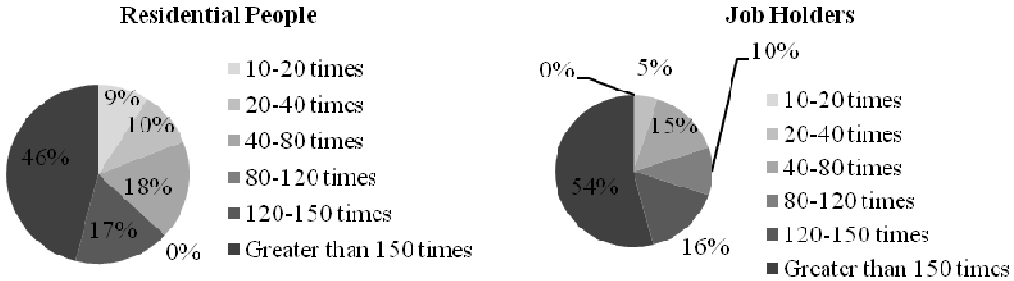

Figure 7: Proportion of People Responding to Frequency of Train Passage

Figure 7 reveals that although majority (46% and 54% for residential people and job holders respectively) of the respondents believes that more than 150 trains pass by their home or residence every day, the opinions are

diverse. People reporting a greater number of trains passing feel that trains disturb them more frequently. However, merely noting the rate of recurrence does not reveal the true extent of harm. It is also important to understand the extent to which respondents are affected each time a train passes. Hence, respondents were asked to rate five pre-selected sources of noise according to the extent of annoyance caused by each source. Figures 8 and 9 illustrate the response. Respondents were asked to rate each source of noise on a scale of 1 to 5, with 1 being most annoying and 5 being least annoying. The surveys reveal that most residential people and job holders consider sound system to be the most irritating source of noise. Opinion is divided for train induced noise and it is clearly evident that most of the job holders consider trains as the second most annoying source of noise. The opinion on train sound is mixed mainly because the respondents live or work at diverse distances from the rail line. People living or working closer to the rail line tend to give more weightage to train. Noise from train attenuates with distance from the rail line.

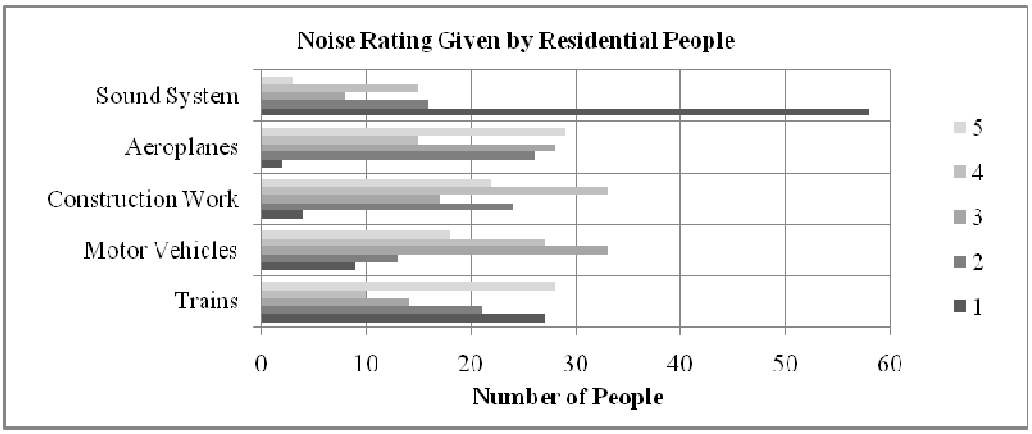

Figure 8: Rating Given by Residential People to Different Noise Sources

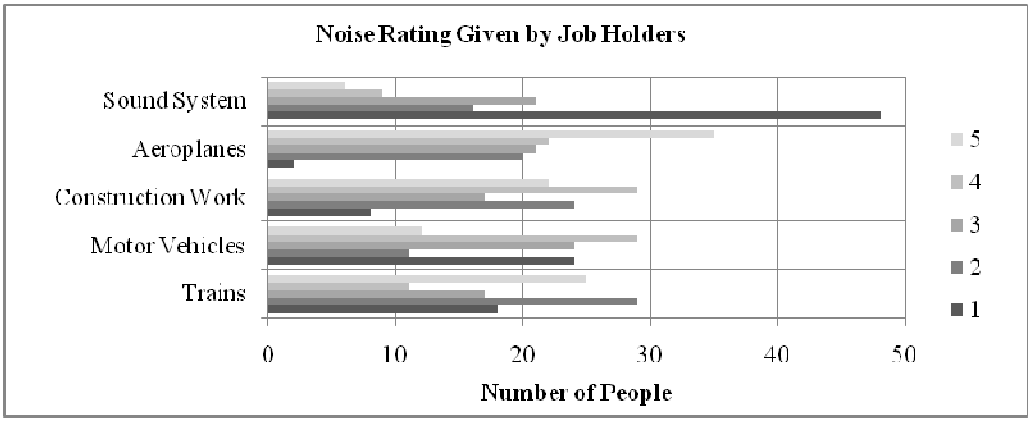

Figure 9: Rating Given by Job Holders to Different Noise Sources

Figure 10: Fraction of Respondents Providing Various Ratings to Train induced noise

Figure 10 reveals that residential people and job holders have similar opinions regarding noise from trains. However, more residential people (27%) compared to job holders (18%) consider trains to be most irritating. On

the other hand, more residential people (28%) compared to job holders (25%) consider trains to be least irritating.

People's response to noise stimuli varies with time of day. There are times when people are more sensitive to noise. Hence it is required to identify when people are most affected by noise, which is depicted in the following charts.

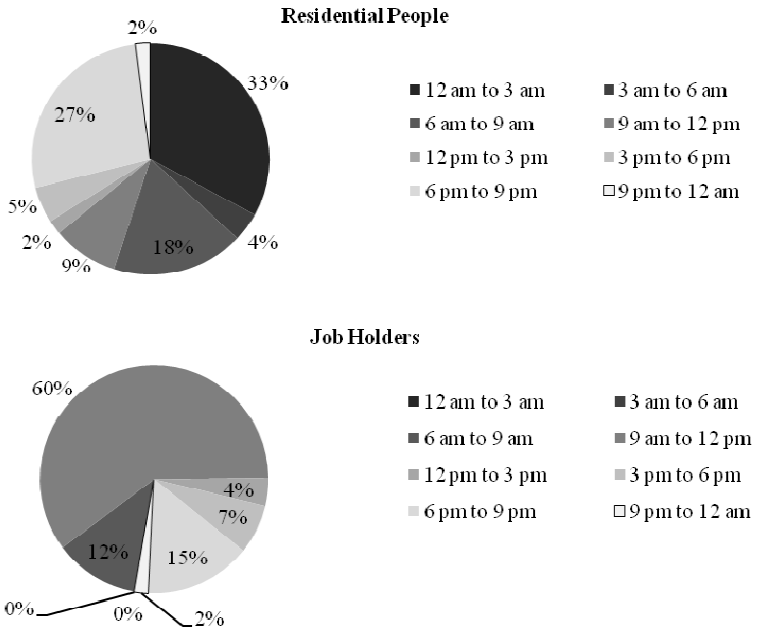

Figure 11: Fraction of Respondents Opionionating on when Noise is Most Intolerable

From figure 11 it is seen that 33% of the residential people feel noise is most painful at night (12 am to 3 am). The chief reason behind this is that ambient noise decreases at night, which apparently increases the amplitude of train whistles. A sizeable portion (27%) mentioned that sound is most annoying when they start their evening studies (6 pm to 9 pm). Thus noise affects two of the most important functions of human beings – sleep and study. Yet another 18 % of the population revealed they are most affected in the morning (6 am to 9 am) when they are preparing to go outside and planning for the day.

For job holders, the overwhelming majority of the population (60%) feels noise is most painful in morning (9 am to 12 pm). As per the workers' point of view this time period is their most productive working period. Another 15% feel noise is most agonizing in the evening (6 pm to 9 pm). These are mainly shopkeepers and grocers selling right beside the rail line. Yet another 12% of employees, mainly shopkeepers, are most annoyed in early morning (6 am to 9 am), when they open their shops. Prolonged exposure to rail noise has drastic effect on human health, which is confirmed by the respondents suffering from various ailments, as illustrated in the following chart.

3.5 Effect of Noise on Respondent Health

Figure 12 depicts the effect of noise on the health of repondents.

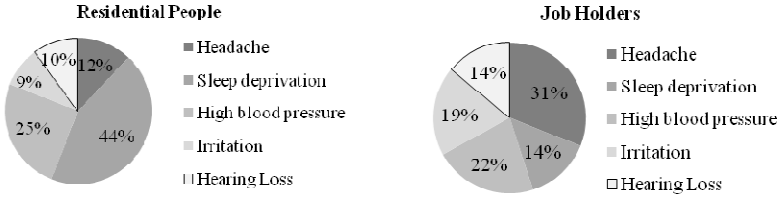

Figure 12: Percentage of Respondents Reporting on Various Ailments Suffered

Almost half (44%) of the residential people complained of suffering from sleep deprivation. Majority of the job holders (31%) suffer from chronic headache. 14 % of the job holders have limited auditory capacity. Such people are mainly day-labourers who work beside the rail line, and may become dazed by sudden bursts of whistles. The ailments are more evenly spread among job holders, while more skewed among residential people. The ill effects of rail noise are further compounded on heart patients and children who find it difficult to concentrate on studies as shown in the following pie charts. Berglund and Lindvall (1995) observed that children are especially vulnerable to noise induced stresses. Health Council of Netherlands (1995) observed the same for heart patients. Hence, these two grooups were considered for the survey. Figure 13 alarmingly points out that 60% of the heart patients are heavily affected by noise, while children of 55% respondents find it tremendously difficult to study in noisy environment. Thus, with time the conditions of those heart patients might have aggravated, and later on they may need special treatment or medication, obviously which would be expensive to bear. On the other hand, children in noise affected areas may perform poorly in assignments and examinations and fail to obtain a sound education background.

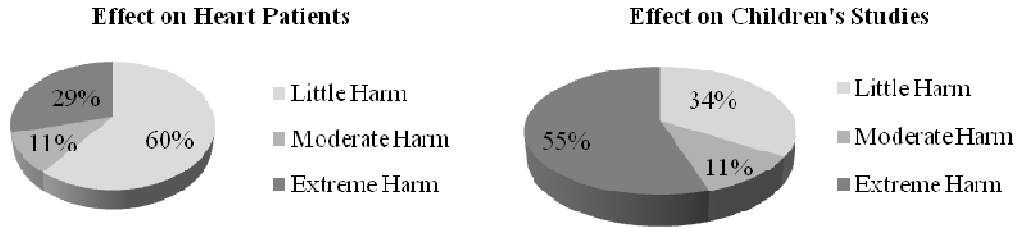

Figure 13: Effect of Noise on Heart Patients and on Children's Studies

It is clear that rail noise has drastic adverse impacts on human beings, in both short run and long run. Knowing this, many respondents were willing to shift their place of work or residence. 56 % of residential people and 42% of job holders were willing to move to a new location. The answers of the respondents who replied in the affirmative are broken down in the following charts.

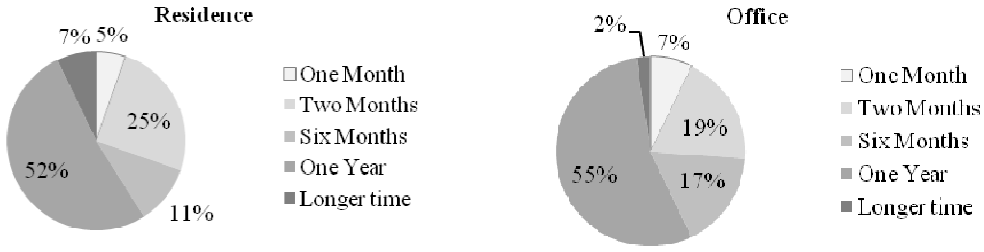

Figure 14: Percentage of Respondents Willing to Shift Place Within Various Time Frames

Figure 14 surprisingly reveals that majority of the residential (52%) and job-holders (55%) wanted to move away within a year. 5% respondents wanted to shift homes while 7% wanted to shift offices as soon as within one month. Meanwhile, people have also been trying to mitigate the effects of noise, as detailed in the next charts.

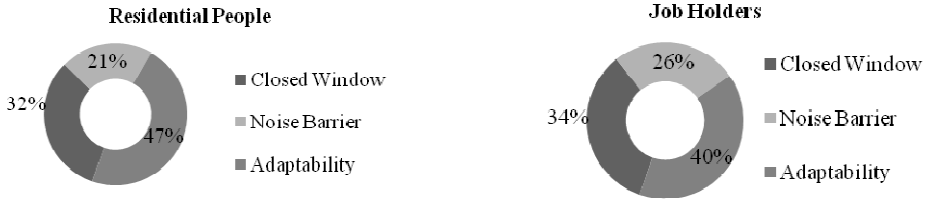

Figure 15: Methods Used to Reduce Noise Pollution

Most people (47% and 40% for residential people and employees respectively) have chosen to adapt to the existing sound levels, as shown by figure 15. Obviously this is the option where the least amount of resources need to be diverted. Besides, as per the respondents' point of view, adapting to noise levels become easier the further they reside or work from railway line. Since Bangladesh is a developing country, setting up noise barriers or taking any noise attenuation measure has not become a widespread option. Around one-third of the people keep windows closed to reduce sound levels. However, this reduces air flow and ventilation. So, to maintain ventilation and keep cool in hot weather, air conditioners are used, which increase the electricity bills in those places.

4. QUANTITATIVE ASSESSMENT OF NOISE POLLUTION

In order to validate the results of the questionnaire survey, noise data were collected at the studied locations. A reconnaissance survey of the selected study areas helped in identifying suitable locations for collecting noise data. At each study area, readings were taken at 100 feet intervals parallel to a suitable stretch of railway line for a total length of 1000 feet. It was desired to collect data from points located 10 feet (32.8 metres) and 100 feet (328 metres) laterally from the railway line, which were situated on either side of the rail track. The lateral distances were so chosen as to cover and replicate the area of the questionnaire survey. The minimum distance of 10 feet was chosen to negate influence of strong winds (speed greater than 10 cm/s) on noise readings. Each stretch of railway line contained at least 1 nos. level crossing, which was found to be a significant place actuating train noise. Google Map was used to pinpoint latitude and longitude of desired points, which were then recorded on paper and identified on field using Global Positioning System (GPS) meter. The noise level was recorded using Rion NL-32 sound level meter. It was used to measure fast A-weighted sound level at 50-100 decibel range and within the range of human audio hearing frequency (i.e. 20 hertz to 20 kilohertz). Equivalent continuous A-weighted noise level readings (LA_{eq}) at 5 minutes sampling time were directly taken from the noise meter at each sampling point. The peak values of the readings (that were taken at 100 feet intervals) at each considered place are tabulated below. Observed ambient noise level readings (noise without passage of train) are tabulated in Table 1. The columns in Table 2 indicate the overall noise levels due to arrival of train. Data were collected at daytime (8 am to 10 am) and at night (9 pm to 11 pm). The observation survey was conducted between 4 June 2015 and 23 July 2015.

Table 1: Ambient Noise Level Readings (L_{eq})

Location	Sound Level at Daytime, L_{eq} (dBA)		Sound Level at Night, L_{eq} (dBA)	
	Lateral Distance of Sampling Point from Rail Line		Lateral Distance of Sampling Point from Rail Line	
	10 Feet	100 Feet	10 Feet	100 Feet
Banani	64.0	64.6	59.5	57.5
Khilgaon	65.8	62.8	55.7	58.4
Moghbazar	64.4	64.7	56.2	56.7
Malibagh	64.5	63.5	55.8	55.3
Kamalapur	66.1	64.2	59.2	58.9
Siddeswari	64.2	65.1	58.2	55.2
Shajahanpur	64.6	62.9	60.1	58.4

Table 2: Noise Level Readings (L_{eq}) Taken During Passage of Train

Location	Sound Level at Daytime, L_{eq} (dBA)		Sound Level at Night, L_{eq} (dBA)	
	Lateral Distance of Sampling Point from Rail Line		Lateral Distance of Sampling Point from Rail Line	
	10 Feet	100 Feet	10 Feet	100 Feet
Banani	84.4	74.2	82.6	78.4
Khilgaon	89.2	75.5	81.8	79.6
Moghbazar	86.5	73.8	82.7	78.5
Malibagh	87.7	75.6	81.2	77.0
Kamalapur	88.4	74.4	85.1	80.9
Siddeswari	85.4	75.8	81.4	78.9
Shajahanpur	89.9	77.6	87.4	72.2

Table 3 indicates the allowable noise level limits set forth at various locations by DOE, which is responsible for enforcing rules and regulations for good governance of the environment. Accordingly, Rajdhani Unnayan Kortripokkho (RAJUK) identified the study areas as residential or mixed, as illustrated in the following table.

Table 3: Noise Level (LA_{eq}) Standards set by the Department of Environment (DOE)

Description of area	Noise Level dB (A)		Study Areas in Each Category
	Day Time	Night Time	-
A sensitive area where quietness is of primary importance	50	40	-
Residential area	55	45	Banani, Khilgaon, Moghbazar, Kamalapur, Shahjahanpur
Mixed area (simultaneously for residential, commercial and industrial purposes)	60	50	Malibagh, Siddeswari
Commercial area	70	60	-
Industrial area	75	70	-

(source: Government of Bangladesh. Ministry of Environment and Forest, 2006, RAJUK, 2015)

The following charts in Figure 16 provide the comparison between allowable noise limit set by DOE and the actual values observed in field. Ambient noise levels have been added for comparison as well.

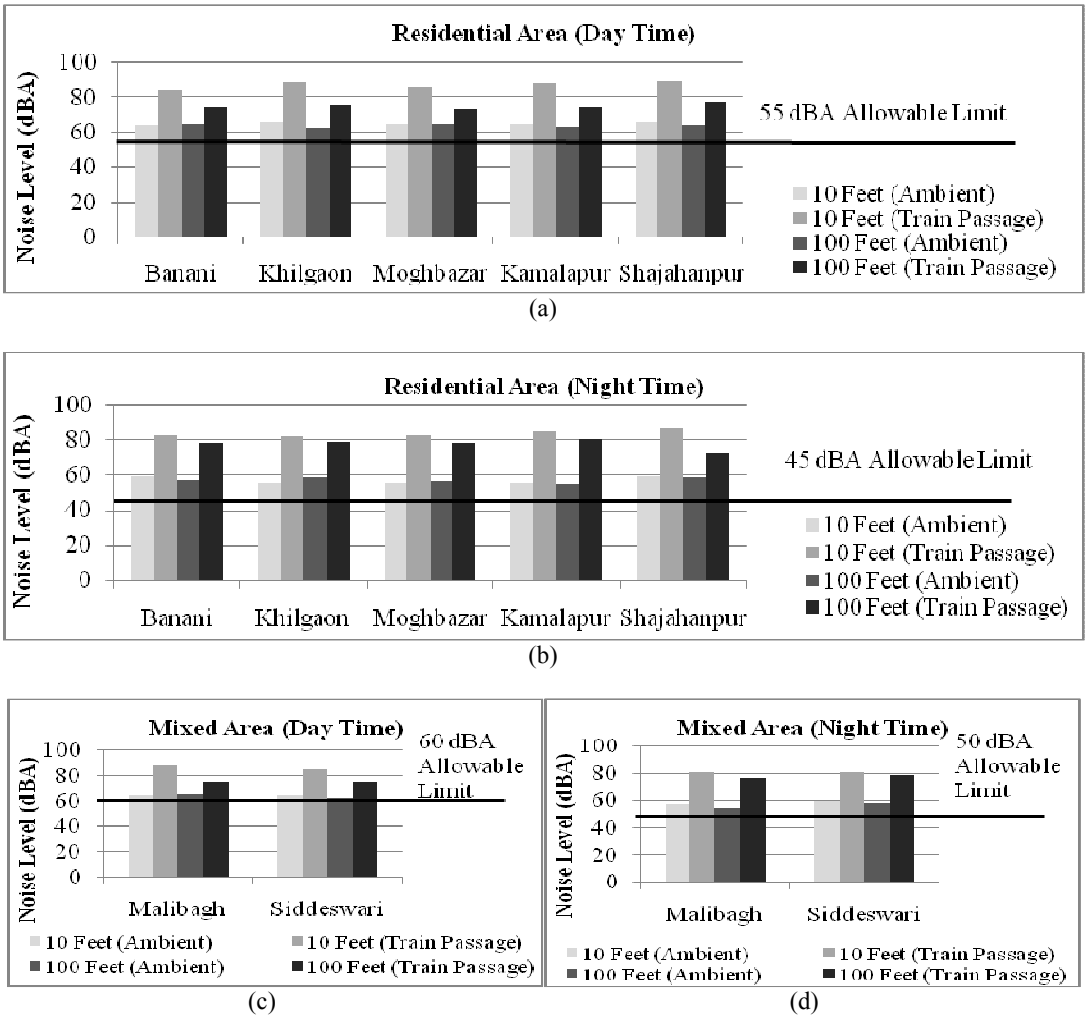

Figure 16: Comparison between Allowable Noise Limit and Actual Observed Values

From Figure 16, it is evident that all of the studied areas have exceeded the prescribed noise limitations, both at day and at night, whose effects extend as far as 100 feet from the railway line. The figure shows that all of the areas, both residential and mixed, have similar noise levels at daytime. Noise levels at night time are also homogeneous, albeit slightly lower than during the day. Alarmingly, Shahjahanpur experiences the highest noise levels – 89.9 dBA during day and 87.4 dBA at night, thus facing the worst noise pollution among the study areas. It has been observed that noise readings decreased noticeably at 100 feet from noise source, compared to at 10 feet, meaning that noise levels decrease markedly further away from the rail line. Moreover, the graphs show noticeable difference (83.7 dBA on average) between background noise and overall noise when a train passes by. Thus, it can be inferred that a train is a significant source of noise within its immediate vicinity (at least for a radius of 10 feet). It is interesting to note that even the observed ambient noise levels are greater than the prescribed limits.

5. CONCLUSION

The most striking observation is that 33% participants at home feel rail induced noise is most painful at night while 60% participants in office consider that the noise is unbearable in the morning. Assessment of noise on the health impact revealed that a shocking 44% residential people find it difficult to sleep while 31% people cannot concentrate on work because of headaches. On average, 34% of the respondents could not initially cope with surrounding noise levels. This figure decreased considerably, but still stands at a noticeable 7.5%, meaning that a striking number of people will never be able to return to life free from noise-induced stress. The questionnaire surveys revealed that most residential people (58%) and job holders (48%) consider sound system to be the most irritating source of noise. Opinion is divided for train induced noise, though it is clearly evident that most of the job holders consider trains as the second most annoying source of noise.It is astonishing to note that 15% of the residential people and 23% of job holders have no concern about noise pollution. On average, 19% of the respondents are not aware of health hazards caused by noise. The noise is hence, a silent health hazard predicament to them. Majority of the residential people (44%) complained of suffering from sleep deprivation, while most of the job holders (31%) suffer from headaches. The survey alarmingly revealed that 60% of the heart patients are heavily affected by noise. In addition, most respondents (55%) assert that their children find it tremendously difficult to study in noisy environment.To escape the adverse impacts of noise pollution, most of the respondents were willing to shift their place of residence or work within one year. Even though most people have to tolerate a variety of noise-induced disorders, the socio-economic conditions of the respondents prevent them from doing anything else other than trying to increase their adaptability to noise.

The quantitative assessment of noise pollution in the surveyed areas alarmingly point out to the significant increase in overall noise levels (an average of 83.7 dBA, 331 times louder than the ambient noise levels). Thus, the field data translates to 33000 % increase in loudness during passage of train, for the entire area of noise reading survey covered. The largest increase in loudness over ambient noise was observed in Shahjahanpur at day time (89.9 dBA increase, or 508.46 times louder). Generally, there is a higher increase in perceived loudness at day time (84.9 dBA) than at night time (81.9 dBA). It has also been obsevered in the study areas that noise levels have exceeded the allowable limits set by DOE. Thus, it is strongly asserted that there are health repercussions in the affected study areas because of increased noise levels, as reflected in the questionnaire survey.

It is evident from the above study that rail noise has hugely impacted people, particularly who have been exposed over a long period of time. Protection from noise usually involves adapting to high amplitude sounds. However, this method runs the risk of leading to deafness, and may cause people to being inattentive to the surrounding environment. Other methods require money, which is not feasible considering the socioeconomic conditions of the majority of the people. Hence, it is urgently required to adopt corrective and preventive measures to mitigate the effects of rail induced noise in affected places. However, there is no panacea for such problem. Rather, it needs to be executed in a controlled and orderly system. The immediate step would be to establish and regulate comprehensive housing policies to prevent further growth of residential and commercial areas beside railway line. In the near future, markets and slums need to be relocated from the rail line. Land constraints in the city necessitate multi-storied buildings to accommodate the displaced people.Existing boundary walls need to be repaired and constructed to ensure full access control measures along both sides of the rail corridor. Access control walls will prevent, to some extent, the growth of slums and markets beside the railway line. The government can use the mass media to make people aware about the risk of noise pollution and encourage them to build houses far away from the railway line. In the long run, however, the effectiveness of the above mentioned solutions will be limited primarily by high population growth and lack of land space for planned development. The long-term solution to noise pollution could be gradual full-grade separation of

Narayanganj-Tongi rail corridor, achieved by making urban portion of the railway tracks as an underground system.

REFERENCES

Berglund, B., & Lindvall, T. (1995). Community noise. *Archives of the Center for Sensory Research*. Stockholm, *2*(1), 1-195.

Goines, L., & Hagler, L. (2007). Noise pollution: a modern plague. *Southern Medical Journal-Birmingham Alabama*, *100*(3), 287.

Government of Bangladesh. Ministry of Environment and Forest. (2006). Noise pollution (control) rules, 2006. *Extraordinary Issue of Bangladesh Gazette*, (pp. 7881-7892). Dhaka: Bangladesh Government Press.

Health Council of the Netherlands. (1996). Effects of noise on health. Chapter 3 of a report on noise and health prepared by a Committee of the Health Council of The Netherlands. In *Noise/News International*, *4*(3), 137-150.

Horne, J.A., Pankhurst, F.L., Reyner, L.A., Hume, K., & Diamond, I.D. (1994). A field study of sleep disturbance: Effects of aircraft noise and other factors on 5,742 nights of actimetrically monitored sleep in a large subject sample. *Sleep*, *17*(2), 146-159.

RAJUK. (2015). Detailed area plan [map]. Scale not given. *Detailed Area Plan*. Retrieved from http://202.79.18.203/Website/Final/viewer.htm

Topf, M. (1988). Noise-induced occupational stress and health in critical care nurses. *Hospital Topics*, *66*(1), 30-34.

Vallet, M., Gagneux, J., & Clairet, J.M. (1983). Heart rate reactivity to aircraft noise after a long-term exposure. In: Rossi G (ed). *Noise as a Public Health Problem*. Milan: Centro Recherche e Studio Amplifon, 965–975.