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Impacts of noise pollution on people's health dwelling in surrounding areas of industrial zones of Gampaha district in Sri Lanka

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Abstract
Industrial noise pollution in Sri Lanka has become an acute issue with the introduction of open economic policy in 1978. Since then, the changing government's industrial policy gradually increased the number of industries, targeting export income. Gampaha district was declared as one industrial zone in 2000 and Biyagama free trade zone in the district is prominent among them. The people who live within 100 m distance from industries or industrial zones are more vulnerable to multiple health impacts. 85% of the industries emit noises, which is above the recommended level of 55 dB (A). The existing laws and regulations cannot be strictly implemented, since it is directly linked with the country's economy and social development. The middle level-contingency approach is the only option to mitigate and manage this issue at a center point. The objective of this study is, to identify and analyze the people's health impacts, arise from the industrial noise pollution in the Gampaha district. The primary data were collected by measuring the noise level at 04 locations of each of 07 industries, questionnaire survey among the 25 households, and structured questionnaire survey among the industry staff, following the purposive sampling method. The secondary data used for this study were extracted from previous literature. MS-Office was used to analyze the data. The results revealed that the dB(A) levels of the selected industries are above the laid down standard of 55 dB (A) level and the highest noise level of 59.5 dB(A) was emitted from the Steel industry at Jaela. The dwellers are impacted with multiple health diseases, *viz*. sleepless (45%), irritation (55%), uncomfortableness (75%), hearing issues (40%), speech issues (75%), and headache (55%). Approximately, 20-30% of respondents have been identified, during the survey; their ordinary way of communication is, speak with a loud sound. Further, 06 industries (85%) accepted that they do not have a noise measuring mechanism, although they are aware of the standards, existing regulations and harmfulness of emitting noise to the environment. This study recommended to re-review and amend the existing regulations, to match with the current requirements and to issue Health Impact Risk Assessment report in parallel to the Environmental Impact Assessment (EIA), prior to grant approval in the future.

Keywords: Noise pollution, health impacts, industries, emissions and vulnerable

Introduction
Noise pollution is considered a major environmental pollutant, which has a positive correlation with human health. It is referred to as the "modern unseen plague". The World Health Organization (WHO-www.int>deafness, accessed on 09.12.2020) [18] states that approximately 360 million people have hearing loss worldwide, out of which 32 million are teenagers. The major courses for these situations are construction sites, entertainment events, traffic, industries, domestic environment, *etc*. Despite Sri Lanka is predominantly known as an agricultural country, since colonial periods; it is recorded an increasing trend of noise pollution, especially around the industrial and free trade zones in Sri Lanka, with the introduction of open economic policy in 1978 and subsequent governments that came to power adopted numerous policies aiming to stimulate the growth of the industrial sector. In 1977, the contribution of agricultural and industrial sectors to the country's Gross Domestic Product (GDP) is 27% and 23% respectively and the agriculture sector's contribution was reduced to 7.42%, whereas the industrial sector reached 27.6% in 2019 (www.sleconomynow.blogspot.com; 03.12.2020). During this process, the Gampaha district was also declared as an industrial zone in the year 2000 with the investments of LKR 36.5 billion from private sectors and LKR 4.5 billion from the Government in the 32 industrial parks in the districts (www.economynext.com; 03.12.2020) [13]. As result, noise pollution has gradually become an acute and growing environmental problem in the district. The Central Environmental Authority (CEA) is the responsible organization for environmental pollutions, including noise pollution matters in Sri Lanka as per the national environmental act no. Act No 47 of 1980.

Objectives
The main objective of this study is to identify and analyze the people's health impacts of industrial noise pollution in the Gampaha district.

Sub objectives
- To identify the causes of noise pollution in the study area.
- To identify and analyze the magnitudes of health impacts of noise pollution in the study area, providing a special reference to industrial noise pollution.
- To provide recommendations to minimize industrial noise pollutions and subsequent health impacts at an acceptable rate.

Research questions

- What are the causes of noise pollution in the study area?
- What are the identified health impacts, resulting from noise pollution (especially industries)?
- What are the remedial measures that can be adapted to mitigate industrial air pollution and health issues?

Justification of the research study

Noise is a pollutant and annoyance occurrence, shall cause multiple human health issues to dwellers to live around the industrial and free trade zone area in the Gampaha district. This has become a recurring and ongoing issue that was impacted people's day-to-day life and peace of mind. Hence, it is a timely requirement to draw regulators and policy-makers attention, highlighting scientific and technical evidence of adverse impacts of industrial noise pollution and reevaluate their operational process that the proper procedures are followed, in accordance with initial approval and Environmental Impact Assessment (EIA) report; understanding the values of the society. Therefore, it is important to know the relationship between industrial noise and the health issues of surrounding dwellers.

Methodology

Study area: The Gampaha district has a land area of 1,387 Km^2 (138,670 ha), which is 38% of the entire land area in the Western province. It is located between 7.087310^0 N latitude and 80.014366^0 E longitude. It has 2.3 million population. It also has approx. 1500 industries, out of which 60 heavy industries are available, under the high pollution category as per the industrial survey of CEA in 2011). The CEA receives around thirty (30) complaints per month and 1/3 of such complaints are against the noise pollution.

Sampling: The methodology was developed to collect both primary and secondary data, following the quantitative and qualitative approaches. With the support of Divisional Environmental Officers, 25 household samples from surrounding dwellers, based on the complaints made to the CEA and 07 industries, to whom made more complaints made were identified, following the purposive sampling mechanism. Each industry's noise-dB level was measured at four directions of each industry. Accordingly, 28 results (7 x 4) were recorded first and thereafter said results were averaged (table-5), using the below formula.

$$\mu = 1/N \sum_{i=1}^{N} x_i$$

In addition, seven structured questionnaires were filled, after the focus group discussion had a few company officials of each industry. The tentative business nature and locations of the above seven industries are listed below and names of the industries have not been disclosed, due to ethical reasons.

- Industry-1: Manufacturing of Cartoons and Packing Materials-Kelaniya.
- Industry-2: Steel industry-Jaela.
- Industry-3: Manufacturing of Packing Materials-Katana
- Industry-4: Tire product manufacturing industry-Uggalboda, Gampaha
- Industry-5: Ceramic products manufacturing-Imbulgoda, Gampaha
- Industry-6: Rubber Export Industries-Mirigama
- Industry-7: Plastic Industry-Ekala.

Respective industry's noise pollution measurements were carried out in accordance with laid down procedures depicted in the National Environmental (Noise Control) Regulations No 01 of 1996, by using British Standard (BS-4142:1997) for measuring industrial noise levels. Subsequently, the household field survey was carried out, using structured questionnaires and more focus group discussion had with selected officials of the industries. Further, the researcher interviewed key-informants, such as Religious Leaders and School Principals/teachers, who are residing in the industrial zone, just to obtain background information. The secondary data used for this study are mainly extracted from previous literature. MS-Office was used to analyze the data.

Data analysis: Both primary and secondary data were analyzed, focusing on the objective of this study, using Microsoft Excel.

Literature review

Mostly, the relevant literature was collected from various sources; such as unpublished reports of CEA, research papers and websites. A few terms were described below.

Noise includes all sounds present in an environment at a point of concern. It includes industrial noise, moving vehicles, household noises, music, *etc*. (www.iberdrola.com, accessed on 07.12.2020) [14]. Basically, any noise that interferes with the lives of people and has the potential to harm them, can be defined as noise pollution.

Noise pollution is sound beyond the standard limit and becomes unwanted and unpleasant, which will adversely impact human health. In order to hear any sound to the human ear, the most important fact is the frequency content of sound waves and the frequency limits of hearing ranges for the average man are from 20 Hertz (Hz) to 20,000 Hz (www.global.widex.com accede on 07.12.2020).

Noise above 65 decibels (dB) is considered noise pollution. Precisely, if it is more than 75 dB, noise becomes dangerous. Consequently, noise levels below 65 dB are recommended during the day, and restful sleep is not possible with noise levels above 30 dB in the atmosphere at night (WHO, 2018).

Industrial Noise includes all noise generated in the industry during its manufacturing or operational process, carried out by the industry to keep the industry alive. Noise emission limits at industrial boundaries are expressed in A-weighted decibel ™ dB (A) š values (www.sciencedirect.com, accessed on 07.12.2020) [17].

Industrial Noise pollution refers to the abnormal sound emitted from the plants and factories – it can have an impact on the people working within as well as those living around these industrial buildings. Depending upon the frequency, amplitude and range of the industrial noise, it may merely annoy those within earshot, and it may also interfere with speech and hearing, causing irreversible hearing damages (www.longdom.org, accessed on 07.12.2020) [16].

Residual Noise means that ambient noise remaining at a given position in a given situation when the specific noise

source is stopped or suppressed to such a degree (National Environmental Act, 1980) [5].

Decibel level is sound is measured by decibels. Each action has a decibel level, from rustling leaves (20 to 30 dB) through thunderclaps (120 dB) to siren wails (120 to 140 dB). Sounds approaching or exceeding 85 dB can damage eardrums. Sound sources that go beyond this are common, including power lawnmowers (90 dB), metros (90-115 dB), concerts (110-120 dB), etc. (National Environmental Act, 1980).

Hearing loss/problems: Our ears can tolerate only a certain level of sound and exposure to high levels of noise over a longer period can lead to infection, deafness and eardrum damage. It also reduces our vulnerability to the sounds that our ears absorb unconsciously to regulate the rhythm of our bodies (www.austinregionalclinic.com, accessed on 07.12.2020).

Causes of noise pollution

The causes of noise pollution in Sri Lanka can be summarized as follows.

Industrial noise: The major causes of industrial noise are machinery, construction and vehicles. The mechanical pneumatic drills, saws, and rotating belts, *etc.* can create intolerably high levels of sound that can irritate the public and adversely affect the employees of engineering companies, textile mills and metalworking factories. Similarly, construction workers, blasting, bulldozing, quarrying, and various other similar activities can create a high intensity of noise pollution (www.sciencedirect.com, accessed on 07.12.2020). Initially, Katunayake (1978) and Biyagama (1982) free trade zone was established soon after the open economic policy. Gampaha district was declared as one industrial zone in the year 2000 and many industries were established in Wathupitiwala, Malwatta, Mirigama and Ekala areas, which lead to noise pollutions in the respective area.

Traffic noise: Traffic noise levels in the Gampaha metropolitan area are higher than the recommended levels. Route busses (horn) produce more than 100 dB noise, which is the polluting noise in the city. The recommended level for Sri Lanka is 63.0 dB, whereas the WHO's recommendation is 55.0 dB (WHO, 2018)

Construction sites: Road development projects, current apartment construction culture and building industries (drilling for piling) in the district create noise above 100 dB.

Use of loudspeaker: Religious places, lottery ticket sellers, bun sellers, used items purchaser (boththal/paththara), political events and open stage musical shows used loudspeaker as public addressing tool.

Stray dogs: Noise made by stray dogs is estimated at around 60-80 dB.

Health impacts of noise pollution

Exposure to continuous, prolonged or excessive noise adversely causes for range of health issues such as stress, poor concentration, productivity losses, communication difficulties, fatigue due to lack of sleep, cardiovascular disease, cognitive impairment, tinnitus and hearing loss *etc*. According to the WHO (2018), noise from planes, trains and vehicles, as well as other city sources, and then looked at links to health conditions; such as cardiovascular disease, sleep disturbance, tinnitus, cognitive impairment in children and annoyance. Another study states that unwanted sound (noise) can damage physiological health. Noise pollution can cause hypertension, high-stress levels, tinnitus, hearing loss, sleep disturbances and other harmful and disturbing effects (www.eea.europa.eu, accessed on 07.12.2020). Existing statistical data shows that environmental noise contributes to 48,000 new cases of ischaemic heart disease per year, as well as 12,000 premature deaths. In addition, it was estimated that 22 million people suffer chronic high annoyance and 6.5 million people suffer chronic high sleep disturbance. As a result of aircraft noise, approx. 12,500 school children suffer from reading impairment in the school (WHO, 2018).

A study revealed that nearly 30 million people in the United States are exposed to hazardous sound in the industrial sector at their workplace every day. Industrial and other types of noise pollution have caused 48 million Americans to lose their hearing abilities. But that's only the tip of the iceberg; prolonged exposure to excessive noise also causes stress, productivity losses, fatigue, communication issues and other more severe problems; such as tinnitus and cardiovascular diseases (WHO, 2018).

A 2004 study that investigated sawmills, printing presses, and corn mills for industrial pollution, found that the noise levels in these industries often exceed 85dB (A). 23% of the corn mill workers, 20% of the sawmill workers, and 7.9% of the printing industry employees showed symptoms of noise-induced hearing loss (WHO, 2018).

As such, the noise is anyway affects people's health and quality of life as stated below.

Hearing problems: Exposure to high levels of noise longer period can lead to hearing problems (www.austinregionalclinic.com, accessed on 07.12.2020).

Sleeping and cardiovascular problem: The excessive noise levels will probably disrupt sleep cycle and cause discomfort. This will impact the success of both at home and in the workplace. There is a growing prevalence of blood pressure, cardiovascular disease, and cardiac stress issues. Studies show that high-intensity noise leads to elevated blood pressure and enhances heartbeat as the regular flow of the blood disrupts (www.quebec.ca, accessed on 07.12.2020).

Psychological issues: Studies show that human and animal excessive noise can be associated with the incidence of aggressive behaviour, sleep disruption, chronic stress, exhaustion, depression, anxiety, hysteria, and hypertension. With increased noise, discomfort increases and people are increasingly becoming patients. This can lead to more serious and chronic health problems later in life. Many children living close to noisy airports or streets suffer from stress and other issues, such as memory, concentration, and reading difficulties (www.quebec.ca, accessed on 07.12.2020).

Cognitive and behavioural problems: Research has revealed that members of society living near airports or

highways typically have more headaches, require more sleeping pills and sedatives, and are more likely to sustain minor injuries and seek psychiatric treatment (www.quebec.ca, accessed on 07.12.2020).

Noise affects the brain: Studies show that noise causes cognitive impairment and oxidative stress in the brain. It has been observed that exposure to noise influences the central nervous system leading to emotional stress, anxiety, cognitive and memory defects (www.quebec.ca, accessed on 07.12.2020).

Moreover, it is pertinent to state that the human's ear is very sensitive and it will never rest, even in sleep. It works and picking-up any sounds around you. It is observed that interrupted sleep will have tiredness, impaired memory, loss of creativity and impaired energy etc. The multiple research findings have shown that people living near airports or busy roads have a higher incidence of headaches, take more sleeping pills and sedatives are more prone to minor accidents, and are more likely to seek psychiatric treatment. Accordingly, this study found that sound plays an important role in human life. However, converting sound into noise will become negatively affect our mental and physical health. Hence, this study appeal to all stakeholders to pay attention on noise pollution, which is caused for serious health impacts to the people and should be managed sustainably.

Avenue to reduce noise pollution

WHO, (2018) considers noise pollution as an invisible enemy, available in the vicinity and it says noise is the second largest environmental cause of health problems, just after the impact of air pollution. This would be mitigated and managed sustainably by implementing the below measures.

The regulatory standards may be set as a long-term goal, while less-stringent standards are adopted for the short term. As a consequence, noise regulatory standards differ widely from country to country (WHO, 2018).

The noise-reducing mechanism should be included with precautions, preventions, mitigation (at source), and management, providing more consideration for designing, insulation, enclosure and maintenance of proposed and existing machinery and equipment.

Environmental education and awareness on noise pollution: Currently CEA carries out many programs on environmental pollution, which requires equal priority to noise pollution too. Education and public awareness. Noise controlling would be successful if basic knowledge is available to the dwellers and industry Officials. It is necessary to include noise in school curricula to study and dissemination of such information to the public more vital through appropriate tools.

Implementation of existing laws: Law enforcement authorities do not pay more attention on noise pollution, since it is an unseen and unmeasurable issue. Despite the laws provided all provisions, there are challenges in measuring noise levels. Hence, CEA and Sri Lanka Police should jointly work with an action plan to fine for exceeding noise limits from any source, including vehicles and industries.

Avoid noisy leisure activities: Use loudspeaker or any other public addressing system must be avoided as much as possible and exiting approval process, from the respective area police station for using such tools, should be re-reviewed and prepared a process with maximum allowable dB (A) level as per the CEA guidelines.

Alternatives mean of transport: Encourage to use electric vehicles instead of fuel consuming cars, especially in the urban area and as such Government should import electrical car instead of fuel cars to meet demand in the market.

Home environment without noise: It is more vital to develop a "noise-free culture" in the home environment. We should allow 'sound' in the domestic environment to become 'noise'.

Legal provisions

All types of environmental pollutions in Sri Lanka are majorly covered by the National Environmental Act (NEA) No. 47 of 1980. This act was subsequently amended by Act No. 56 of 1988 and Act No.53 of 2000 to provide more legal provisions, considering the ongoing practical and recurring environmental related issues. Sections 23(A), 23(P), 23(Q), and 23 (R) elaborates on the way of controlling noise pollution. In addition, the National Environmental (Noise Control) Regulation No.01 of 1996 comprehensive explanations *viz*., allowable noise limits (table-1), measurement, calculation, application details and industrial noise pollution *etc.* have been emphasized. This has been subsequently gazetted under reference no.924/12 dated 21 May 1996. Subsequent gazette notifications Nos. 1466/26 dated 12.10.2006 and 2090/11 dated 25.09.2018 also provide more details on noise pollutions.

The CEA engaged in various activities to protect and manage the environment by adopting existing environmental laws and regulations. The CEA issues Environmental Impact Assessment (EIA) and Initial Environmental Evaluation (IEE) certificates, after evaluating the possible environmental impact of proposed projects. Accordingly, the CEA issued 17 EIA approvals and 266 IEE approvals in 2019. In order to regulate environmental pollution, the CEA granted Environmental Protection Licenses (EPL) to the companies of potentially polluting industries (CBSL, 2019).

Table 1: Maximum Permissible Noise Levels at Boundaries in LAeq' T-Domestic level

Area	$L_{Aeq,}$ T value**	
	Daytime	Nighttime
Low Noise	55	45
Medium Noise	63*	50
High Noise	70	60
Silent Zone	50	45

Note: * The noise level should not be exceeded 60 dB (A) inside the existing houses, during the daytime.

Table 2: Maximum permissible Noise Levels at Boundaries of the land in which the source of noise is located in L_{Aeq}', T for construction activities.

L_{Aeq}', T value**	
Day time	Nighttime
75	50

Table 3: Maximum permissible Noise levels at Boundaries in LAeq, T, for industrial activities.

Area	L_{Aeq}, T value**	
	Daytime	Nighttime
Rural Residential Area	55	45
Urban Residential Area	60	50
Noise Sensitive Area	50	45
Mixed Residential	63	55
Commercial Areas	75	55
Industrial Area	70	60

Source: Table-1, 2 & 3 extracted from National Environmental Act No. 47 of 1980.

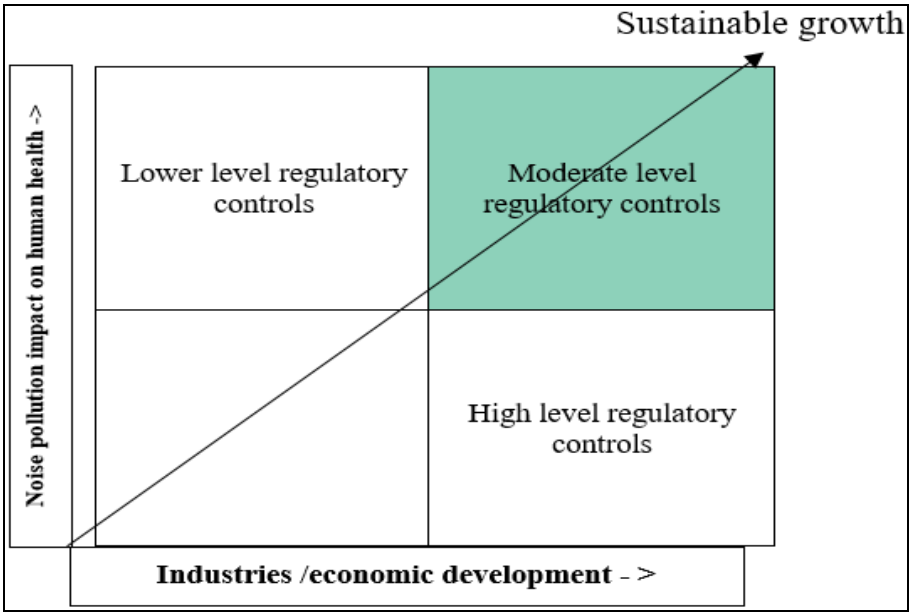
**"LAeq'T' means the Equivalent Continuous A-Weighted Sound Pressure Level determined over a time interval T (in dB-Decibels).

LAeq: the steady noise level which contains the same amount of acoustic energy as all the varying noise levels observed during a particular time period.

"A-weighted" means a process of automatic adjustments made to the output of the sound sensor in a sound level meter, so that the reading of the meter takes into account the frequency characteristics of the human ear".

dB (A)-A weighted continuous precision integrated sound pressure level

Sri Lanka, as a developing country, existing laws and regulations cannot be strictly implemented, this is a sensitive issue directly linked with countries economy and social development. In fact, the high degree of noise pollutions, beyond the standards impact the health of the people, dwelled around the industries, but continued operation of such industries is needed for countries development. Each of these developments leads to an increasing trend of noise, which will have an adverse health impact on people around it. If the government implement flexible/weak noise control mechanism, it will have a continuously increasing trend of in noise pollution and associated adverse health risk. If the government enforces strong regulations to combat against noise pollution, on the other hand, it will affect the production of the industry, thousands of laborers in it and ultimately countries economy. Hence, law enforcement authority must follow a middle level-consistency approach to manage both one to one contradictory elements at a center point towards sustainable growth. Below figure-1 emphasized this statement in summarized form.



Source: Prepared by the Researcher, based on informants of selected sample industries, 2019.

Fig 1: Correlation in-between regulations, health impacts and Industry /economic development

Results and Discussion

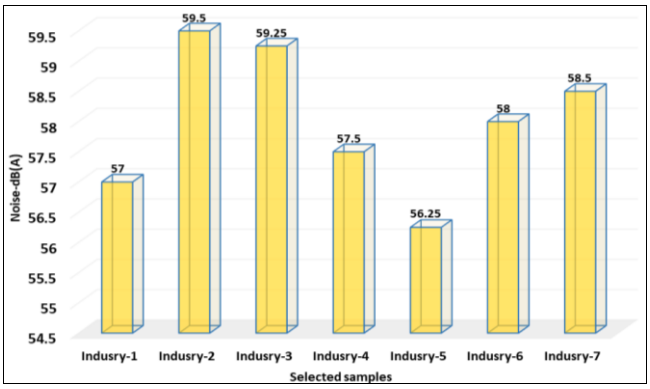
A). Measurement of dB level: The dB (A) levels of the selected industries were measured in the 04 direction of each industry with the assistance of the Divisional Environmental Officer of the area. The noise levels at four directions/locations of each selected industry of 07 samples, the total amounting to 28 directions, were measured at the investigator's convenience. The measured results were averaged to make the analysis eased (table-1). Analysis reveals that selected industries' noise levels were recorded, beyond the laid down standard of 55 dB (A) level; which is varied within the range of 5 dB (A), among all selected industries. According to below figure-1, the highest noise (59.5 dB (A)) was emitted from the Steel industry at Jaela. In fact, very hard materials manufacturing industries will emit the highest noise. If the average all industries result to arrive one figure (58 dB (A)), it is still above the recommended standards, which will lead to adverse health impacts to the people around it. Moreover, it was observed that most industries use outdated and poorly maintained machineries. This has majorly become a reason for high noise emission. Further, this study found that the size and nature of the manufacturing products; dB (A) level of the industry could be varied. Hence, the location of the industry should be decided, taking into consideration size and nature of the industry and population spread around it (90% live within 100m distance). CEA is requested to carry out a Health Impact Risk Assessment (HIRA) with the assistance of health authority; in parallel to Environmental Impact Assessment (EIA) to ascertain the both human health and environmental risk. Every industry must have a process to measure the daily noise level of respective industry electronically and should be available such records for

inspection by their internal audit or respective law enforcement authorities.

Table 4: Noise emission from selected industries

Industries	Average noise level dB (A)	Max. permissible noise level dB (A)**
Indusry-1	57	55
Indusry-2	59.5	
Indusry-3	59.25	
Indusry-4	57.5	
Indusry-5	56.25	
Indusry-6	58	
Indusry-7	58.5	
Average od all industries	58	

Source: Field study-2019 and **NEA, No. 47 of 1980



Source: Field study-2019.

Fig 2: Noise emission from selected industries Average corrected noise level-dB (A)

b). Household survey: According to the results of the household survey (table-5), most residential properties were situated within 100 m distance from the industries. The dwellers are impacted with health diseases, *viz*. sleepless (45%), irritation (55%), uncomfortableness (75%), hearing issues (40%), speech issues (75%) and headache (55%). Approximately, 20-30% of respondents have been identified, during the survey; their ordinary way of communication is, speak with a loud sound, even another party stays closer to him/her. According to the investigator of this study, this practice is their ordinary way of talking, even in a noise-free environment. However, 1/3 of them had speech and hearing issues, due to the continuous exposure to the industrial noise.

Although 75%, 78%, 90% & 60% of the dwellers had thorough understanding of existing regulations, adverse impacts on their vicinity, health impacts and severity of noise pollution respectively, but 40% them have only made complaints to the relevant authority. Respondents have fed-up keep on complaining and a few of them stated that the industries provide temporary solutions only, since the cost for a permanent solution is very expensive.

Noise pollution harms the performance of the school-going children (80%) and the children below 11 years (48%), as they are absorbing noise into their ears. This would impair their performance, self-confidence, courage, concentration on studies and memory power *etc*.

The above results clearly show that the dwellers around it are suffering from industrial noise. It has various practical issues that controlling noise pollution, under existing regulations as the non-availability of sufficient assessment procedure and the existing National Environmental (Noise Control) Regulation was enacted two decades before in 1996, which should be re-reviewed according to the current requirements.

Table 5: Facts of summary derived from the household survey

Result items	Mode of analysis	Percentage (%)
School attending children	Education wise	80
Infants below 11 yrs	Age wise	48
Residential Location from industry	Distance lesser than 100m	90
Dwellers @ home (weekdays)	Time spending at home	20
Dwellers @ home (weekends)	Time spending at home	80
Noise from industry	Frequently	60
Noise from industry	Continuously	20
Noise level- moderate	Severity of noise	28
Noise level- severe	Severity of noise	60
Complaints made	Complaints to authority	40
Aware on existing regulations (yes)	Knowledge on regulations	75
Noise polluting your vicinity (yes)	Knowledge on pollutions	78
Noise impacts your health (yes)	Knowledge on pollutions	90
Sleepless	Diseases wise	45
Irritation	Diseases wise	55
Uncomfortableness	Diseases wise	75
Hearing issue	Diseases wise	40
Speech issues	Diseases wise	75
Head ache	Diseases wise	55

Source: Field study-2019.

It was observed in the developed countries that the deafening sound free and calm environment, which is more favorable for both physical and mental health of the general public. It was observed an opposite atmosphere in developing countries, including Sri Lanka and day is started with the sound of the religious places and Bun Seller's loudspeaker. Further, the public exposes to loud sounds, while departing from home for work in numerous ways, mostly horns of route buses, which is not in accordance with standards sound limits. This has been directly linked with their culture and perceptions since the developed countries understood that noise pollution adversely resulted for public's mental and physical health of thousands of people by way of a range of short and long-term health issues

(hearing losses, sleep disorder, stress, high blood pressure, cardiac and cardiovascular effects, reduced productivity in workplace and school students and audiology disorders *etc*). However, the people do not consider that the noise everywhere around us, as a pollutant; because they have been addicted to live with it and also it cannot be tasted, seen or smelled by the dwellers, around the industries. They ignore it until it starts causing havoc with their health. According to the Sri Lanka Police, approx. 8000 motorists have been imposed penalties for using the unstandardized horn in the tote busses in 2019. Hence, noise pollution is not an "underestimated hazard" as correctly said by WHO. Noise pollution has everyday implications for millions of people's health.

c). Survey on Industry staff: According to the sampling scheme, 07 structured questionnaires were filled, after discussing with selected seven industries. The summarized details are given in the table-6.

Table 6: Facts of summary derived from Industry officials

Result items	Percentage (%)
Noise measuring mechanism available (No)	85
Aware on standard noise level (yes)	85
Woking on Sunday/Poya day (No)	90
Woking in the night, after 8.00pm (No)	90
Noise emitted by industry (yes)	85
Complaints received from dwellers (yes)	70
Do you aware on existing regulations (yes)	85
Will noise pollute the vicinity? (yes)	85
Will noise impact the human health?(yes)	85
Impaired Social relationship	95
Staff-Uncomfortableness	85
Staff-Hearing issue	28
Staff-Speech issues	42
Staff-Head ache	28

Source: Field study-2019.

According to the study, 06 industries (85%) accepted that they do not have a noise measuring mechanism, although they (85%- same six industries) aware on the standards noise level, existing regulations and emissions of noise to the environment, which is harmful to the dwellers around it. To achieve the target mostly during the last week of the month, some industries continue their daily operations until 7.30-8.00 pm. However, 90% of the industries do not operate after 8.00 pm. The 05 industries (70%) stated that they used to receive frequent complaints about the noise. If such a situation is aggravated, machineries and equipment are being serviced by their Vendors. Above stated 6 industries (85%) understood that noise pollution will lead to multifarious health problems to their staff, as well as dwellers. According to their HR records, 85% of industries stated that their staffs (mostly factory labours) have uncomfortableness in their daily lives, similarly, 28% of industries' staff member had hearing issue; 42% if industry disclosed that their staff has speech disabilities and again 28% disclosed-regular headache of their staff. Respondents from all seven industries, except for a few staff (95%) stated that the operational process of the industries has impaired the social relationship between the company and people.

Conclusion and Recommendations

Industrial noise negatively impacts the health of surrounding dwellers, since most of the industries do not care about this issue and not complying with the standards and existing regulatory requirements. However, both dwellers and industries, selected for this study, accepted that noise from industries are emitted to the environment are above the recommended standards; which could create multiple health issues and also well-aware on applicable regulations and standard too. Both parties had perceptions that industries operational process cannot be stopped, rather than the mange it below the standards dB (A) level; since it is interconnected to the country's economy (figure-1). Generally, frequent exposure to the noise, above the standards level; some time will not bring health impacts, but continuous contact with noise will definitely have an impact. Accordingly, this study had the strongest evidence for health effects, such as hearing problems and speaking disability and also on children's health. Ultimately, the children's education and quality of life of surrounding dwellers had large drawbacks.

Accordingly, the following recommendations were suggested, based on this study.

- The existing National Environmental (Noise Control) Regulation, which was enacted two decades before in the year 1996, should be re-reviewed and prepare an amendment, according to the current requirements in terms of control, mitigation and management to maintain the quality of our environment, below the standard level,
- CEA should extend education and awareness for both industry officials and dwellers with regard to the Noise pollution, same as the other programs conducted by the CEA at present and also should provide a process/checklist to monitor and mitigate industrial noise, introducing possible surveillance systems for noise-related adverse health impacts.
- Every industry must have a process to measure the daily noise level of respective industry electronically and should be available such records for inspection by their internal audit or respective law enforcement authorities.
- Central Environmental Authority (CEA) is requested to carry out a Health Impact Risk Assessment (HIRA) with the assistance of health authority; in parallel to Environmental Impact Assessment (EIA), issued to the industries to ascertain the both human health and environmental risk.
- This study suggested to control noise at the source, i.e. at the time of selecting of machinery and adhering to the correct maintenance process (lubrication and maintenance) of the machines in a periodical basis. Investors should be fortified to consider noise emission (weighted sound power) into account when purchasing machineries and other equipment.
- It is advisable to grant approval for new industries, if the building is constructed with suitable noise absorbing materials, wherever applicable, as the noise is an environmental pollutant that affects the community in day to day life.
- Installation of barriers in between industry and residential area is alternative tactics that international companies are used, to break the risk level of noise. Since it has a large cost, this should be implemented, understanding the background of the industry. Further, this study suggested to establish industries 400-600 m

away from the residential location, within the designated industrial zone, which will make noise exposure minimal, although the understanding of such a situation is not always possible.

- The Central Environmental Authority (CEA) is the responsible organization for environmental pollutions, including noise pollution matter. Hence, it requested to redo the existing guideline issued on 21st of May, 1996, incorporating current requirements.
- There should be a strict process to grant approval to use loudspeakers among public places.
- Growing cluster trees around the boundary lines (green belt) of the respective industry as a noise breaking buffers will reduce noise levels by 10 dB approximately.
- It is recommended to adopt noise management mechanisms with precautionary and mitigation procedures, according to the geography of the area (physical environments, schools, playgrounds, residents and hospitals *etc*.) should be prepared for industries to adhere.
- Lack of research in this field was observed. It is suggested to carry out further research in this subject matter with the mingle of scientific and social-science perspectives.

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