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Noise Pollution and its Effect on the Profitability of Industrial Companies: A Study from Cement Factories in Jordan

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This study focuses on economic and social aspects which are crucial in noise pollution which sharply affects laborers' performance and industrial firms' profits.

It has been concluded that noise pollution has affected worker performance and production. Therefore industrial factories and firms have fitted barriers to avoid the transfer of noise to other parts of the factory.

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Noise Pollution and its Effect on the Profitability of Industrial Companies: A Study from Cement Factories in Jordan

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I. THEORETICAL BACKGROUND

Numerous forms of environmental pollution have appeared these include: (radioactive pollution, light pollution, and noise pollution). Thus, environmental pollution, particularly noise pollution is a significant problem facing the modern era, an era of advanced and sophisticated technology, so instead of human activities being consistent with this progress and development, it took place at the expense of the environment, Due to the lack of accurate scientific knowledge about noise pollution in most countries and its impact on workers in factories and companies, therefore its impact on the national economy as a whole, Our study was created to discuss the economical expenses of noise pollution, its influence on the profits of corporations, and how to handle the problem of noise pollution and limiting its negative impact on economies and societies.

1. Does noise pollution affect the performance and productivity of workers?
2. Does noise pollution has an impact on the profits of a company?

II. SIGNIFICANCE OF THE STUDY

The importance of this research stems from the progress made in various fields of life, especially

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technological development, which led to effects on societies, individuals, and in particular on the economy, such as the environmental pollution, specifically noise pollution.

Since that there are many causes of noise pollution and it has a variety of dangers on the economy, it has to be recognized, its measurement methods and its impact on employees who are considered the main factor affecting a company's profit plus the economical wheel.

III. OBJECTIVES OF THE STUDY

1. Highlighting the impact of noise pollution on the performance of employees in industrial companies
2. Clarifying the role of noise pollution on the profit of industrial corporations.

IV. HYPOTHESES OF THE STUDY

1. H00: Noise pollution does not affect the performance of employees in industrial companies.
2. H00: Noise pollution does not affect the profitability of industrial companies.

V. METHODOLOGY OF THE STUDY

The descriptive and analytical approach is to identify the characteristics of the phenomenon of noise pollution and to describe the nature and quality of the relationship between the performance of employees in industrial companies on one hand and profitability on the other, its causes, and trends.

a) *The Society and Determinants of the Study*

The society of the study covers cement factories in Jordan as a model to study the effect of noise pollution on their employee's performance and profitability, as for the determinants of the study is that it is studying the internal effect of noise pollution on factories' employee's performance and profitability, but it is not studying the external effect of noise pollution.

b) *Previous Studies*

1. (Altoranji, 2008) Titled the financial costs of noise pollution and its effects on the social economic units, in which the researcher made clear that the phenomenon of noise pollution is expanding and increasing rapidly, the researcher showed that noise

pollution has negative effects on individuals and communities and it has a reflection on societies and economies. The researcher also discussed different aspects of noise pollution and the financial cost of production at (Srziar Cement), in addition, in his study the researcher included supplements of the financial statements of the cement plant showing the final budget for wages and salaries for the fiscal year ending in 12/31/2005 which demonstrated that the plant suffered of high wages and salaries, the researcher concluded that the machines in the plant produced higher noise levels than allowed (85dB) without attempts of using other equipments or attempts of holding substrates of equipments with substances like lid or plastic to decrease the sharpness of the noise, added to that is that workers do not have the proper tools to decrease noise levels like (Sound protectors and ear plugs). All of these elements has dangers on the health and efficiency of the workers as well as causing losses in the plants profit, workers pay and the overall financial system.

2. Assessment of Noise Pollution in the Ashuganj Fertilizer Industrial Area, Ashuganj, M. S. Sultanaa, N. Jahana, M. S. Islamb and S. M. Masum, Bangladesh J. Sci. Ind. Res. 46(2), 183-190, 2011.

Noise pollution in industries is now a serious environmental concern in Bangladesh. In this study sound levels are observed inside the Ashuganj Fertilizer Company Ltd (AFCL) Ashuganj. Continuous running of high speed turbo machinery, vibration of pipelines and structures, transmission of high pressure gas, sudden release of high pressure gas generate noise hazard inside the factory during the time of production. The sound level data was collected at seventeen different locations in the ammonia production plant, ten different locations in the urea production plant and ten different locations in the residential area of AFCL. In the ammonia plant, significantly high level of sound was observed (>90dB) from the process gas cooler, let-down station, boiler-feed water pump, synthesis-gas compressor, process air compressor, alternator and ammonia compressor areas. In the Urea plant, Prill tower (top), Prill tower (absorber vent) are the most noise vulnerable areas with sound level >90 dB. Residential area found less affected by noise pollution (43-53 dB) but in some areas like playground, main gate of the residential area sound level sometimes cross the standard sound level of residential area (50 dB). In the ammonia and urea plant, the sound levels are much higher than the standard sound level (75 dB) for the industrial area, which is considered a hazard of noise may induce hearing loss, annoyance and other adverse effects on the health of the workers of AFCL. Therefore, some remedial measures should be taken to reduce the sound level inside the factory. Researcher confirmed on a number of results was the most prominent of the

maintenance of machinery in factories help to reduce noise pollution.

3. Industrial Noise and Its Effects on Humans, (Atmaca, Peker, Altin), Journal of Environmental Studies, Vol. 14, No. 6 (2005).

The problem of noise in the industries around Sivas has been examined in this study; and noise measurement and survey studies have been carried out at concrete traverse, cement, iron and steel and textile factories located in this region. A questionnaire was completed by 256 workers during this study in order to determine the physical, physiological, and psychosocial impacts of the noise on humans and to specify what kind of measurements have been taken both by the employers and workers for protection from the effects of noise. It has been specified, during the surveys, that the noise levels detected in all the industries are much above the 80 dBA that is specified in the regulations: 73.83% of the workers in these industries are disturbed from the noise in their workplaces, 60.96% of them have complaints about their nervous situations, 30.96% of these workers are suffering hearing problems although they had not had any periodical hearing tests and they are not using ear protection equipment.

4. Fighting Pollution When Decisions Are Strategic, institute of economic, Academic Publisher, University of Hamburg, Kluwer Academic Publishers, Volume 76, 1993.

In this paper, the author analyzes antipollution policies in a 2-by-2 game played between a 'polluter' and the 'police' in which the payoffs can be manipulated by an exogenous third player called the 'policymaker.' He shows that the efficiency of the policies may depend on whether the players of the 2-by-2 game choose Nash equilibrium strategies or prefer maximin.

5. Noise action plan – the strategic approach to advance sustainable transport the example of “Quiet Norderstedt. Worth living”, Herbert Brüning (Germany), Werner Gronau, Karl Reiter & Robert Pressl (Ed.), Transport and Health Issues, Mannheim 2011.

The study concludes that traffic noise represents a major but widely underestimated problem. For city residents however, noise increasingly plays a central place in choosing residential areas and desiring a change; the subjective perception of noise is an important catalyst for moving. Local authorities are, therefore, well advised to protect their populations effectively against noise. If they also encourage a modal shift to more environmentally friendly transportation and keep the remaining motor vehicle traffic at low speed levels.

- c) *What Distinguishes this Study from Previous Studies*
Previous studies discussed the subject of noise pollution and its effect on the environment in general,

individuals in particular; it also identified its impact on the economy, social and psychological aspects. And they also mentioned ways of decreasing the intensity of noise pollution.

But what distinguishes this study from other studies is that it looks at noise pollution from the accounting side and its effect on laborers' performance which in turn reflects on the profitability of industrial companies. In addition to the accounting treatment of noise pollution, that makes it as one of rare studies that discuss this issue from the previous perspectives.

VI. THEORETICAL FRAMEWORK

There is no doubt that certain circumstances surround workers in industrial companies during their daily performance at work in one way or another affect the achievement of their various duties as well as the pace of the work done, therefore there are some conditions that could make it easier for workers to perform their duties and on the other hand conditions that hinder progress and hinder their performance.

The behavior of an individual as a result of the interaction of two sets of variables is looked at as follows :-(Ghareeb, 2003)

a) *The characteristics of the worker*

What the worker has of qualifications, skills, readiness to face difficult situations, and problem solving during his professional duty.

b) *Work conditions surrounding workers*

The conditions that has either a positive or a negative impact on a worker during professional duty or different work tasks, these conditions can vary however some of them include (Lighting, noise pollution, working hours, incentives and rewards, and breaks)

Considering that noise pollution is one of the natural conditions affecting laborers' performance, this research comes to study the effect of noise pollution on the performing and psychological state of laborers in industrial companies and what results in a company's progress and profitability.

VII. POLLUTION

There are a lot of definitions for the term "pollution" this study has taken the most important definitions and listed them below:

- Is a change in the environment that surrounds living creatures, it is humanly induced and it causes an emergence in substances that doesn't fit an environment a creature is living in, which causes a disruption (Alhyali, 2009)
- A term that means all the methods in which human activity causes damage to the natural environment, pollution can be seen at an area that is exposed to waste or by spotting black smoke coming out of a factory. (Altoranji, 2008)
- A change in the harmonic motion that occur between

components of the biological group system which leads to loosing the ability to sustain life without problems (AlRasheedi, 2012)

According to the above information it is shown that pollution has numerous effects on individuals and the environment altogether, where it leads to the emergence of some psychological and social problems for company employees which in turn reflects on the productivity and profit margin of a company.

a) *Noise Pollution*

Noise is a type of air pollution in the form of waves; the word noise is derived from the Latin expression "NAUSES". There are a lot of different definitions for the word noise, for example the British encyclopedia defines noise as "the unwanted sound" whereas the American encyclopedia defines the term as "the undesired sound". (AlShowki, 2010).

Noise is an annoying unwanted sound; it causes inconvenience, stress and possibly deafness it accompanies general productivity and manufacturing processes, the severity of noise can vary depending on the nature and quality of those processes (Atheer Abdullah Mohammad, 2011).

It is an overlapping combination of annoying sounds that affect the organic human health and the nervous system if the permitted limits of sound exposure were exceeded for an eight hour daily period of work for five days without it having a changing impact on a worker's hearing ability, a few of the disease caused by tension are Ulcers, blood pressure, diabetes and atherosclerosis (Alhyali, 2009).

i. *Effects of Noise Pollution*

The debate about noise pollution can be presented in various and diverse dimensions, some of these not inclusively include: (Alhyali, 2008)

1. Noise causes 50% of the errors in mechanical works.
2. 20% of fatal accidents are the results of noise pollution.
3. A 20% waste of working days.
4. Weakens the immunity in children, increases the risk of migraines in children, and it also weakens their educational abilities, growth and hurts their intellectually.

Therefore we should follow procedures to limit the dangers of noise. If exposure to noise was not decreased protective hearing equipment must be provided, and it should be available as precaution while planning the control of noise pollution. (Atheer Mohammad, 2011).

To reduce the effects of noise pollution one or more of the following measures should be followed:

1. Isolating machines that produce noise
2. Lining the walls with sound-absorbing materials in order to prevent reflection

3. Installing barriers near machinery to reduce the spread of noise
4. Placing rubber under machines to minimize their noise
5. Carrying out regular maintenance of machinery, lubricating them, and linking their noise causing parts
6. Increasing the distance between the spatial working machines that cause continuous or intermittent noise
7. Using tight ear plugs

ii. *Noise pollution sources*

Noise pollution is one of the most damaging types of environmental pollution, in some countries, for example Egypt, road transport noise is about 60% of the causes of noise pollution.

Based on that some sources of noise pollution can be mention not inclusively as follows: (Wikipedia)

1. Automobile noises: In a prepared study "residents of the cities of Jordan" it shows that after measuring the level of traffic noise in 47 locations in the capital Amman with a limit of 78.5dB it caused inconvenience for residents, and as long as traffic is growing faster than cities noise pollution will increase.
2. Noise from factories : Is one of the most dangerous types of noise pollution it is sourced from factories or workshops, it affects workers in these areas and the people living by these industrial areas, auditory senses of laborers in large factories gets impacted day after day, and this might lead to deafness in the long run.
3. Aircraft noises: this problem occurs to nearby airport residence, although aircrafts are becoming less noisy due to advancing in the production of aircrafts.

iii. *Types of noise pollution*

Noise pollution Types by source appear into three sections as follows (Hayali, 2008)

1. *Chronic pollution*

Is the individual's exposure to noise permanently and continuously, causing a sustained weakness in hearing

2. *Temporary pollution with physiological damages*

Is the individual's exposure to noise for a short period of time, like exposure to fireworks for example and it causes infections in the middle ear.

3. *Non damaging temporary contamination*

Is the exposure to noise for short time intervals, like noises from streets and crowded places which cause a temporary weakness in hearing.

a. *Cement factories noise*

Noise in the cement industry is represented in the following sites: (Bea'tna Magazine- Journal of the environment- Web)

Blasting, Cement plants are often built close to areas where limestone can be found, because 80% of raw mix has limestone in it. Due to the need for such large quantities of material, blasting operations are needed; resulting in loud noises that disturb residents in nearby areas, danger increases when blasting operations are coincided with hefty vibrations that could cause damages to residential buildings that are close to mining areas.

To reduce the impact of the blasting, the necessary measures must be taken to ensure a population free zone in mining areas and surrounding territories, reducing the amount of explosives in the blasting process, and using environmentally friendly chemicals instead of explosives.

- Equipment and machinery noise: using crushers and mills in cement production to break down raw materials results in a loud noise that should be avoided and it is important to wear ear protectors to limit the effects of the noise which can alter hearing ability overtime.

b. *Measuring the intensity of sound and its effects (Abdul Hussain, 2013)*

The intensity of noise is measured in a special unit called (Decibel); the scale starts from 0dB for severe dim sounds up to 130dB were pain causing sounds are.

The (Bel) unit for sound measuring devices descended from the name of its American creator (Bell), one tenth of a unit is usually used in measuring (Decibel) and it is a logarithm for the pressure in sound waves to a reference pressure 0.0002 microbar.

All the sounds that we hear daily fall under the main levels measured in decibels and these levels are: (Alhyali, 2008).

1. *40-50 dB range*

Leads to effects and adverse reactions that takes shape in tension, and effects in the cerebral cortex, which leads to psychological discomfort, disorders and a lack of health harmony *60-80 dB range*.

Has bad effects on the nervous system, it also leads to severe headaches, reduces the ability to work and it causes disturbing dreams (nightmares).

2. *90-110 dB range*

Lowers hearing ability, causes nervous and cardiovascular systems disorders.

3. *120dB or Higher*

Causes pain in the sound system, serious repercussions on the cardiovascular system, and it also leads the inability to distinguish sounds and their direction.

c. *Measuring noise levels according to "OSHA" specifications*

OSHA specifications state that 90dB is the permitted level of noise exposure for a period of:

8 hours a day for 5 days causes no damage; it also considers 85dB as the limit to which precautions should start to be taken at. The following diagrams will

show different noise levels and the permitted exposure time for them:

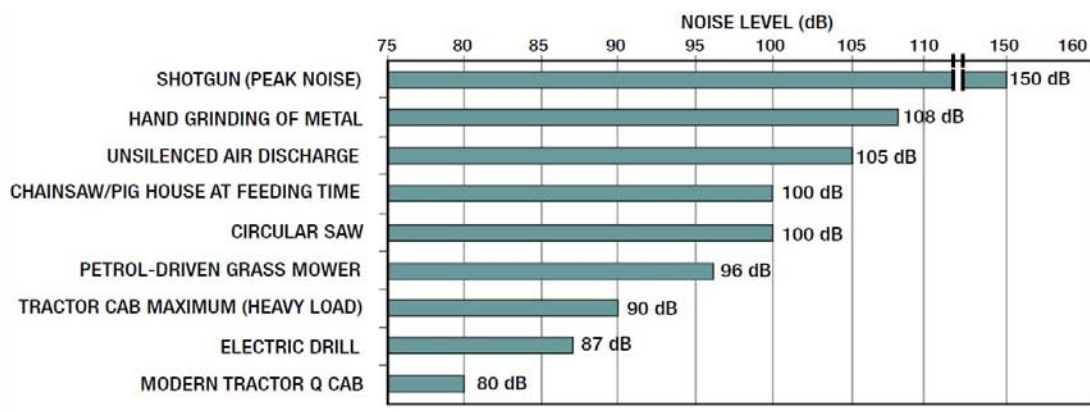


Table 1 : Sounds levels of common construction hand tools

Tools	Average	Peak	Longest exposure without hearing protection (each day)
Powder-actuated tool into masonry	107-110	147	Nil (based on peak exposure)
Powder-actuated tool into timber	100-104	143	Nil (based on peak exposure)
Paslode nail gun	97-104	138	Nil (based on peak exposure)
Electric grinder (on aluminium)	98-102	123	8 minutes
Cut-off saw	98-102	118	8 minutes
Hand-held planer	96-100	114	15 minutes
Masonry drill (timber then concrete)	96-100	111	15 minutes
Bench rip saw	95-99	116	15 minutes
Circular saw	94-98	113	15 minutes
Hammering nails into timber	93-97	131	Nil (Based on peak exposure)
Bench grinder	92-96	113	30 minutes
Jigsaw	91-95	112	30 minutes
Belt sander	91-95	105	30 minutes
Router	90-94	108	1 hour
Electric chainsaw	89-93	112	1 hour
Electric drill into timber	87-91	100	2 hours
Electric sander (1/3 sheet)	79-83	103	8 hours

Noise at work

Guidance for employers on the Control of Noise at Work Regulations 2005

VIII. THE COST AND EFFECTS OF NOISE POLLUTION

When workers become exposed to noise producing equipment that exceed the allowed noise limit of 85dB without the use of any equipment or devices to reduce noise levels:

a) The cost of sick leave

Sick leave cost was calculated based on workers who experienced higher noise levels than 85dB and for workers who experience less than that.

b) The cost of lower productivity from workers as a result of noise pollution

According to studies, the decline in productivity rate for workers who are exposed to high noise is 30%, therefore the cost of this worker can be calculated as follows:

The cost of lower productivity per worker.
 = Worker's annual salary * rate of productivity decline.
 = 4800 * 30%
 = 1440 JOD

*Cost of the low productivity of all of the factory's workers annually
 = Cost of the low productivity of all of the factory's workers annually.
 = The cost of lower productivity per worker* number of workers.
 = 1440*1200
 = 1728000 JOD

c) *The cost of limiting noise pollution using sound proof ear plugs*

One American made sound proof ear plug costs 20 JOD in the local stores (Jordan) and it has the life span of five years.

d) *Cost of noise reduction using sound proof ear plugs according to the straight molecular installment*

Overall cost/ Life span

e) *The effect of reducing noise pollution on profits*

= The cost of noise pollution – The cost of reducing noise pollution
 = (The cost of sick leave + the cost of lower productivity) - The cost of reducing noise pollution

IX. PROPOSED ACCOUNTING METHODS OF DEALING WITH NOISE POLLUTION

As previously mentioned there are many effects on individuals and the environment caused by noise pollution, as a result companies have a lot of losses that need resolving by opening accounts, including:

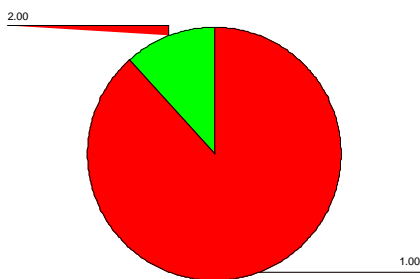
- The account of low productivity losses
- The account of sick leave variations
- The account of noise reducing equipment costs

a) *Firstly: the characteristics of the study sample*

1. *Gender*

Percentage	Count	Gender
% 88.5	23	Male
% 11.5	3	Female
% 100	26	Total

It's noted that 88.5% of participants are males and the rest are females

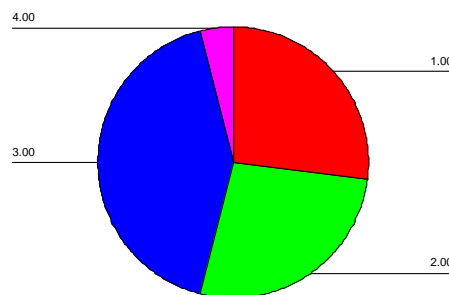


2. *Academic Qualifications*

Percentage	Count	Qualification
%26.9	7	High School
%26.9	7	Diploma
%42.3	11	Bachelors
%3.8	1	Masters
-	-	PhD
% 100	26	Conclusion

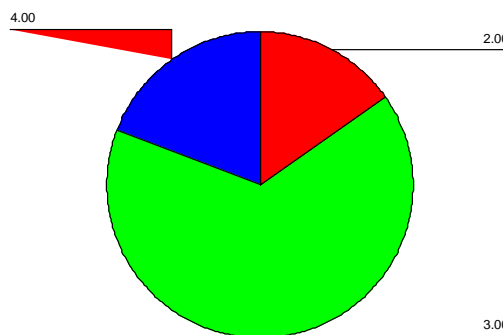
It is noted that 42.3% hold a bachelors degree, 26.9 % hold diplomas and 3.8% hold a masters degree.

3. *It turned out that all of the participants are workers*



4. *The company's legal form*

We note that 65.4% of the samples are companies with a limited contribution, followed by 15.4% limited joint-stock companies, while 19.2% of the samples are companies assume an otherwise legal form.



b) *Secondly: A display of the results of the study*

The arithmetic mean and standard deviation were calculated to describe the sample answers about the paragraphs below:

Arithmetic Mean	Standard Deviation	Paragraph Number
4.3077	0.78838	1
4.1154	0.71144	2
2.3462	1.16421	3
3.2692	1.07917	4

4.3846	0.69725	5
2.2692	1.31325	6
3.3462	1.01754	7
4.1923	0.69393	8
3.6538	1.12933	9
3.0000	1.29615	10
2.7692	1.30561	11

We note that the positive direction of the paragraphs above is because their arithmetic mean is higher than the value 3, while paragraphs (11,6,3) have a negative standard deviation and that's because they have an arithmetic mean of less than the value 3

c) Thirdly: Stability Test

The Cronbach's alpha test was used to measure the stability of the measuring tool to measure the accuracy of the measurement device, as ($\alpha = 75.91\%$) which is a good result as it is higher than the average value (60%).

d) Fourthly: Hypothesis testing

i. First Hypothesis

H0: noise pollution has no effect on the performance of employees

H1: noise pollution has an effect on the performance of employees

The test results of the first hypothesis

Hypothesis Nihilism Result	SIG T	Actual Value of T	Calculated Value of T
Rejected	00.	2.0595	7.857

ONE SAMPLE T TEST was used, we find from studying computer results in the above table that, (Calculated T Value = 7.857) is larger than its actual value and since the decision rule is to accept nihilism hypothesis (HO) if the calculated value was less than the actual value, in addition nihilism hypothesis (HO) will be rejected if the calculated value is larger than the actual value, therefore the nihilism hypothesis (HO) is rejected and the alternative theory (H1) is accepted which means that there is an **effect for noise pollution on the performance of workers.**

ii. Second Hypothesis

H0: Noise pollution has no effect on the profitability of industrial companies

H1: Noise pollution has an effect on the profitability of industrial companies

The test results of the Second hypothesis

hypothesis nihilism result	SIG T	Actual value of T	Calculated value of T
Rejected	0.221	2.0595	2.653

ONE SAMPLE T TEST was used, we find from studying computer results in the above table that, (Calculated T Value = 2.653) is larger than its actual value and since the decision rule is to accept nihilism hypothesis (HO) if the calculated value was less than the actual value, in addition nihilism hypothesis (HO) will be rejected if the calculated value is larger than the actual value, therefore the nihilism hypothesis (HO) is rejected and the alternative theory (H1) is accepted which means that there is an **effect for noise pollution on the profitability of industrial companies.**

X. CONCLUSIONS AND RECOMMENDATIONS

a) Conclusions

- Noise pollution is a form of environmental pollution; it's not any less dangerous than other types of pollution, therefore interest in it was raised newly because of its consequences on members of noise exposed societies according to the location and time periods. In this research we attempted to measure the damage economically, of what noise pollution leaves of losses on individuals and diverse economic projects.
- As a result of the study and observation, it shows that machines and equipment produce high levels of noise and there are attempts to use barriers to stop noise from spreading to other sections. Factories distribute protecting equipment to lower noise levels to the permitted limit like sound proof materials and ear plugs
- The study shows the effect of noise on a worker's performance, that it has negative effects on their health and efficiency, and that it causes losses for workers, factories and the overall economy. Whereas the study has shown that noise pollution has no effect on the profitability of industrial factories.

b) Recommendations

- Conduct regular check-ups for workers in factories, help with diseases resulting from noise pollution and noise of machinery at the expense of the factories
- Work to provide the newest methods and equipment to limit the effects of noise pollution, and forcing workers to use the protective equipment
- Planting trees near factories, especially noise producing areas, because trees have the capability to absorb noise

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