

# Study the Auditory Pollution Effects of Electrical Generators for Some Locations in Fallujah City

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## Abstract:

Noise pollution is one of the most prominent features of contemporary society as a source of anxiety and instability through its impact on human health and the quality of life that people live in the city of Fallujah. Seven different selected locations representing the home and educational environment in urban areas were measured, and noise levels in these residential and educational areas were assessed. To compare them with WHO limits for sound pressure levels, to assess the level of noise to which people are exposed in indoor environments. The results of the current study showed sound levels higher than required inside homes and educational settings. As for homes, the highest sound level was 75 decibels and the lowest sound level was 27 decibels in the Al-Amriya residential complex, while the highest sound level in the educational environment was 90 decibels and the lowest sound level was 53 decibels in the College of Administration and Economics - University of Fallujah.

While the highest sound level was 110.5 decibels and the lowest sound level was 58.7 decibels in Fallujah Teaching Hospital.

Individuals' exposure to high levels of noise in educational institutions and in their homes means that they are exposed to noise pollution for longer hours, which negatively affects their health.

The aim of the research is to study noise pollution in the city of Fallujah and find out its sources, resulting in negative effects on humans, while developing ways to treat it.

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## Introduction

The civilized development for human beings harmed their environment and all the organisms living in it. Noise pollution is a result of technology and one of the important problems in cities around the world. It has adverse effects on the behavior and productivity of the organisms and the quality of life.

The environment has been taken care of in general and the issue of pollution in particular, and at various levels, whether on the public formal education institutions or the non-formal education institutions. In spite of the great interest in environmental education programs, the reality of this situation is still that environmental care and importance are modest and insufficient to effect the desired effect in developing environmental awareness.

Noise is progressively becoming ubiquitous, yet an ignored form of pollution in developed and developing countries noise pollution is a threat to health and well-being, an environmental stressor and nuisance. It is one of the foremost environmental pollutants that has direct effects on human performance. The continued survival of man is contingent upon the enabling environment where he resides, as disruption in the conducive environment may lead to dysfunction in his health status. Urbanization, civilization or industrialization is majorly characterized with noise pollution.

Noise was derived from the Latin term 'nausea' and has been defined as unwanted sound, which is a potential hazard to health and communication. Noise was defined by Bridger (1995) as a sound or sounds at such amplitude that could cause annoyance or interfere with communication. Many workers are exposed to noise at work place and this exposure is the second most important cause of hearing loss after aging process.

Noise pollution interferes with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps, and behavioral changes. These include problems with concentration, fatigue, uncertainty, lack of self-confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships, and stress reactions. Some of these effects may lead to increased accidents, disruption of communication in the classroom, and impaired academic performance. It also causes stress, mental health effects and neurobehavioral effects.

Electric generators used widely in all places in Iraq which produce some chemical pollutants to the environment. Diesel generators emitted several gases and compounds, which cause air pollution and harmful effect on the health of workers in generators. The biggest bioenvironmental problem now is air pollution in the world. A large amount of pollutants, such as carbon monoxide (CO) exhausted from cars, is released into the air every day that long-period exposure to releases from diesel generators has been reported to cause "dizziness, cardiovascular and respiratory problems, eyes' irritation, nausea, drowsiness, headache, dizziness, drowsiness, death, unconsciousness.

Electrical generators used in living quarters when electricity is cut off, is a significant source releases of air pollutants. Electricity generating plants are characteristically associated with noise and vibration which are unfriendly to human health and the environment. Noise emanates from different sources such as automobiles, machines, household devices, industrial, commercial and residential. Most previous studies concentrated on evaluation of noise pollution. However, there are few studies that have investigated the effect of the noise and air pollution produced by generators on workers.

### ***1-1 Type of pollution***

The European Commission has defined pollution as-"The discharge by man of substance or energy into the environment, the results which are such as to cause hazards to human health, harm to living resources and to ecosystems, damage to amenities or interference with other legitimate uses of natural resources". Anyway, the simplest definition known by most is that, the increase of the contaminant level such as toxic and hazardous waste disposal, bad odour, haze, sewage etc.. or other particular substance in an area that produces unhealthiness, uneasiness and unpleasant place to live in. Or In other word; "too much of something In the wrong place". Actually, It is because of the natural environment stability in the ecosystems are being disturbed.

Man has realized the adverse effect of development pollution. Pollution is manifested In many forms such as air, water, toxic waste, solid waste, noise and occupational health. But man must also aware that the cause of pollution can affect the growth of the National Development. It is necessary to be aware about the future impact of pollution which may create damaging effect to the world ecology. Specific health effects on human are only part of the cost of environmental degradation.

Nowadays, the source of pollution usually comes from toxic substances that contained some chemical which have the potential to cause environmental damage. It may also cause destructive health to the living organism such as human, animals, insects, aquatic life and plants, even death and extinction of certain habitats. However, it is wrong to say that pollution is caused entirely by human because there are also natural sources for many contaminants. Perhaps our environmental pollution can be divided into two major sources of contaminant .

### ***1-2 Noise Pollution***

The term noise pollution has been defined as a sound without agreeable musical quality or as an unwanted or undesired sound. Noise is no less a pollutant than the toxic chemicals In the environment. As a result of increasing mechanization, the use of increasingly voluminous and complicated machinery and equipment and the stepping up of the pace of production, the noise is becoming an increasingly wide-spread and serious source of discomfort and danger. Definition given in the ILO(International Labour Organization) convention no. 148 is that the term noise covers all the sound, which can result In hearing impairment or be harmful to health or otherwise dangerous. In most of the countries comparatively very little attention has been rewarded to the noise phenomena. In spite of its importance in the urban and industrial sectors, it has been observed that people residing in the urban areas and many occupationally exposed workers develop severe hearing losses. There is much to suggest that noise hazard is gradually more prejudicing social life and in some instances hearing capacity. The prevention of noise induced hearing loss therefore should be accorded top priority. Sudden and unexpected noise has been observed to produce marked changes in the body, such as increase in the blood pressure, increase in heart beat and muscular contractions, and the flow of saliva and gastric juices will be decreased .

### ***1-3 Methods of prevention of pollution***

Take preventive precautions.

1. Maintaining hygiene in its various forms, including: personal hygiene, clean working environment, water, and soil.
2. Ensure the correct use of pesticides.
3. Waste disposal and disposal in the right way.
4. Getting rid of rodents and insects and eliminating them permanently.
5. Noise reduction.

6. Continuation in afforestation and erection of retaining walls in order to reduce the capacity of air pollutants.

### **2-1 Examples of Decibels (DB) Reading**

Noise or sound is measured in decibels (dB). A person's hearing can be damaged if exposed to noise levels over 75 dB over a prolonged period of time.

#### **Painful**

120\_140 dB = jackhammer, jet plane take-off, amplified rock music at 4-6 ft.

#### **Extremely Loud**

90 dB = lawnmower, shop tools, truck traffic, subway

#### **Very Loud**

60-80 dB = dishwasher, alarm clock, busy street, vacuum cleaner, normal conversation

#### **Moderate**

40-50 dB = moderate rainfall, quiet room

#### **Faint**

30 dB = whisper, quiet library

The continuous directed exposure to certain force sound waves can reduce the ability to hear or cause the deaf. The high intensity of sound can cause damage to the nerve cells of the inner ear. Consequently, the nerve cells are gradually eroded, and the exposed person will be deaf .

The human ear is damaged as a function of sound level exposure time, and frequency content of the sound. Sound intensity is measured in units of decibels (dB), which are expressed on a logarithmic scale. On the decibel scale ,sound intensity increases tenfold for every additional 10 dB. Thus, an increase from 60 dB (conversation) to 90 dB (heavy traffic) is equivalent to a 1,000-fold increase in intensity. The ear is less sensitive to very low and very high frequency sounds, but rather sensitive to mid-frequency sounds. This sensitivity is captured by A-weighting ,which is essentially a band pass filter emphasizing frequencies between 1000 Hz and 4000 Hz and de-emphasizing frequencies below and above this range. Decibels are a measure of sound intensity that can be expressed in terms of several reference levels; dBA is sound intensity with an A" contour filter that adjusts the measurement to be less sensitive to very high and very low frequencies. Hence ,noise exposure is described in A-weighted decibels (dBA) Identifying and managing children with hearing loss Given the difficulties that children with hearing loss face in academic contexts, it is essential to identify these children early and accurately. There may be hearing loss if children repeatedly display the following behaviors:

- Ask for repetition.
- Misunderstanding what they are told.
- Appearing inattentive to tasks that involve listening.
- The child has problems with some sounds (such as fricatives and pause).
- Children watch others to understand what they say or do.
- The child feels exhausted at the end of the day.
- Withdraws from situations that require good listening skills.

Noise is defined as loudness (intensity) and pitch (frequency) and noise level measured using a logarithmic scale such as decibels (dB) . Recent research shows that noise pollution now poses serious health risks in our modern societies . The prevalence of auditory and non-auditory effects is widespread among workers/operators working in a noisy environment. Non-auditory risks of noise include: irritability, anger, memory loss, and sleep disturbances. The World Health Organization estimated that there are 360 million people in the world with hearing loss, of whom 91% are adults and only 9% are children. The incidence of disabling hearing loss in Southeast Asia is 2.4% among children; 9.5% in adults under 65 years of age, and up to 48% in adults over 65 years of age. The most common causative factor for this age-related deafness is noise pollution. The National Institute on Deafness and Other Communication Disorders estimates that 15% of the population experiences reduced hearing intensity due to loud noise, which may be noise from work, recreational activities, or cell phone use alone .

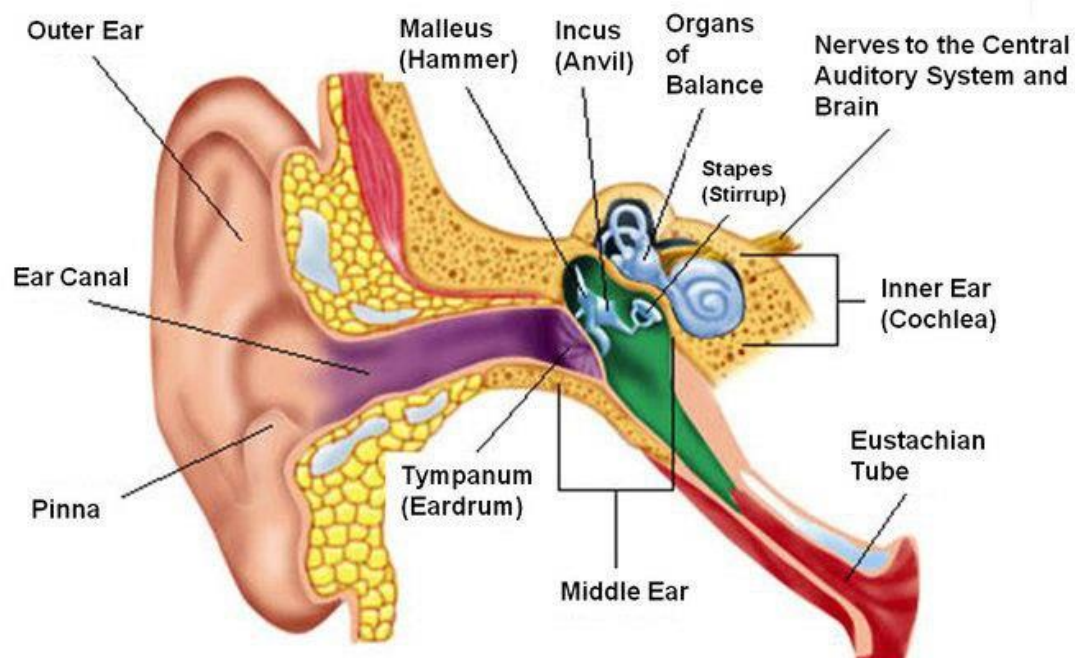
## 2-2 Anatomy of the ear

The ears are the primary organs of hearing the sounds produced usually outside and perceived inside the body by the brain .

The human ear and its neurological connections to the brain represent a complex and sensitive hearing mechanism that is vulnerable to damage .

The high intensity of sound can cause damage to the nerve cells of the inner ear. Consequently, the nerve cells are gradually eroded, and the exposed person will be deaf.

### 1. Outer ear



The outer ear transmits sound to the tympanic membrane .

#### 1:1 pinna

The pinna, that part which protrudes from the side of the skull, made of cartilage covered by skin, collects sound and channels it into the ear canal. The pinna is angled so that it catches sounds that come from in front more than those from behind and so is already helpful in localizing sound .

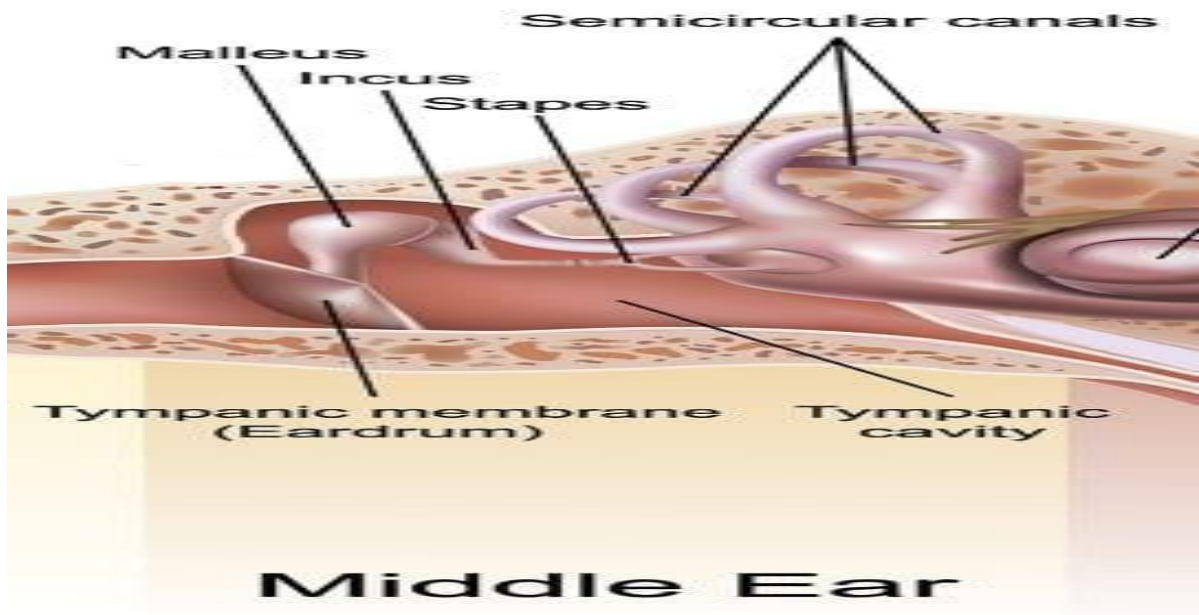
#### 1:2 Ear canals

The ear canal is about 4 centimeters long and consists of an outer and inner part. The outer portion is lined with hairy skin containing sweat glands and oily sebaceous glands which together form ear wax. Hairs grow in the outer part of the ear canal and they and the wax serve as a protective barrier and a disinfectant. The bony thin skinned Inner portion, so that the outer part runs somewhat backwards and the inner part somewhat forwards. This bend is yet another part of the protective mechanism of the ear, stopping foreign objects from reaching the tympanic membrane .

### 1:3 tympanic membrane:

Tympanic membrane separates the ear canal from the middle ear and is the first part of the Sound transducing mechanism. Shaped somewhat like a loudspeaker cone (which Is an ideal shape for transmitting sound between solids and air), It is a simple membrane covered by a very thin layer of skin on the outside, 1/10th of millimeter thick. It covers a round opening about 1 centimeter In diameter into the middle ear cavity [26].

## 2. The Middle Ear



**The middle ear:** It is an air-filled cavity located behind the tympanum and connected to the pharyngeal cavity via the Eustachian tube, which is responsible for equalizing atmospheric pressure on both sides of the tympanic membrane. In the middle ear are the three **ossicles** of hearing, the malleus, the anvil, and the stapes.

**Malleus bone:** It is the bone that connects the inner tympanic membrane to the anvil bone, and is the largest bone in the middle ear.

**Anvil bone:** It is the bone that mediates between the malleus and the stirrup, forming a link between them.

**The stirrup bone:** It is the smallest of the **ossicles**. It connects the incus to the septum that separates the middle ear from the inner ear, which is known as the oval window.



**The primary function of the middle ear** is to transmit sound waves and frequencies from the outer ear to the Inner ear, where the middle ear processes and amplifies these waves before sending them to the inner ear.

The middle ear is also known as the tympanic cavity, which is a cavity lined with a membrane filled with compressed air and containing the hearing ossicles.

### **The function of the middle ear in the sense of hearing:**

Transmission of sound waves through the outer ear.

The outer ear collects sound waves through the pinna and passes them to the eardrum through the auditory canal.

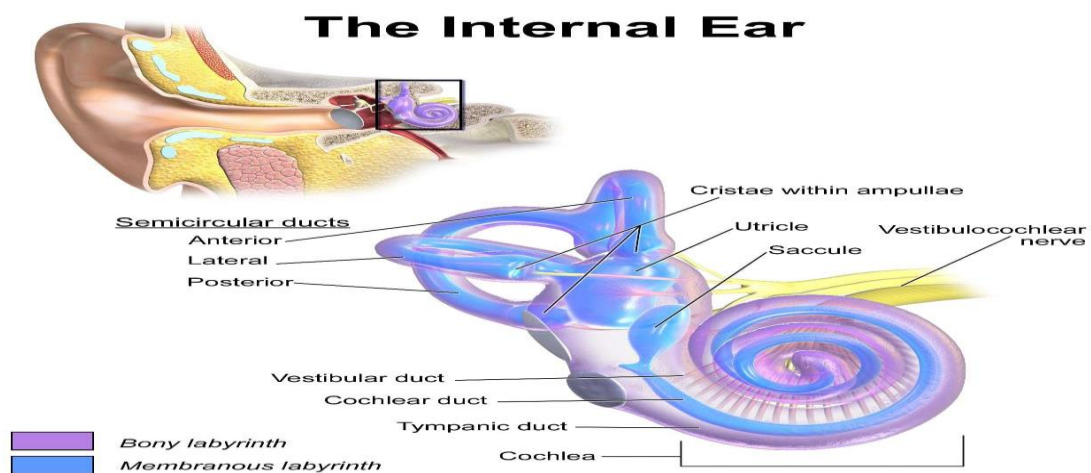
Eardrum vibration- The tympanic membrane acts as a barrier between the outer ear and the middle ear. This membrane vibrates when sound waves collide with it, causing vibrations that are transmitted to the middle ear.

Vibration of the ossicles of the middle ear when sound waves reach the middle ear, the ossicles begin to vibrate, as the malleus bone pulls the anvil aside by the synovial joint that separates them. By this mechanism, the anvil bone, a type of middle ear bone, will displace the stapes bone, opening the oval window and passing sound waves to the fluids inside the inner ear.

This bone conduction amplifies sound waves more than 10 times as they travel through the outside air. Sound waves reach the inner ear

The inner ear consists of three parts, which include the cochlea, which contains the hearing nerves, the vestibule, and the semicircular canals, which contain balance sensors. Once sound vibrations enter the Inner ear, the sound is converted into nerve signals that are transmitted to the brain via the auditory nerve, and the brain works to translate them into sounds.

### **3: Inner Ear**



**The inner ear:** Is the last and most complex part of the ear. It contains many delicate structures connected to each other, sometimes called the labyrinth. It is a group of complex passages consisting of a bony labyrinth surrounding a smaller membranous labyrinth. The space between the bony labyrinth and the membranous labyrinth is filled with incompressible body fluid called perilymph. Perilymph is high in sodium but low in potassium and is similar in chemical composition to perilymph in the blood and cerebrospinal fluid surrounding the brain. The space within the membranous labyrinth is filled with another incompressible fluid in the body called endolymph. Endolymph is low in sodium but high in potassium and it is chemically similar to the intercellular fluid found inside the body's cells.

The Inner ear consists of for main parts

1. the vestibule
2. the semi-circular canal
3. the cochlea
4. the auditory nerve

**1\_The vestibule:** A small room, circular in shape, about 5 mm long. It represents the middle part of the Inner ear. Its bony walls connect the semi-circular canals and the cochlea. Inside it there are two sacs, each of which resembles a bag, and they are called the “utricle” and “sacculus.” These sacs and tubes are collected. Information about head position and movement. The brain uses this Information to help maintain balance. The saccule and utricle are located in the vestibule and contain cells that sense straight-line head movement (I.e. forward and backward), acceleration, up-and-down movement, and gravity.

**2. The semi-circular canals** are located behind the vestibule and consist of three filled tubes perpendicular to each other so that they can sense the rotation of the head. The rotation of the head causes the movement of fluid in those canals. Depending on the direction of movement of the head, the movement of fluids is greater in one of the canals compared to the movement of fluids in Other channels. The semicircular canals contain hair cells that respond to the movement of fluids. The hair cells send nerve impulses that tell the brain about the direction of head movement, and thus the brain gives commands to the motor system to take the appropriate position to maintain balance.

If the semicircular canals malfunction, which can occur In the context of an upper respiratory infection or other temporary or permanent disorder, a person may experience imbalance or a false sensation of movement or rotation (vertigo).

**3 The cochlea:** It is located in front of the vestibule and Is similar to a spiral shell. It consists of a snail that rotates around itself twice and a half times. Inside it are three tubes wrapped around it and filled with liquid. The first tube starts from the oval window and the second starts from the round window. These two tubes meet at the top of the snail. The third tube, called the cochlear tube, is located between the first two tubes. It contains the basilar membrane, which contains more than 15,000 hair cells, and these cells make up the organ of Corti, which is the actual organ of hearing. There Is another membrane above the capillary cells called the tectorial membrane

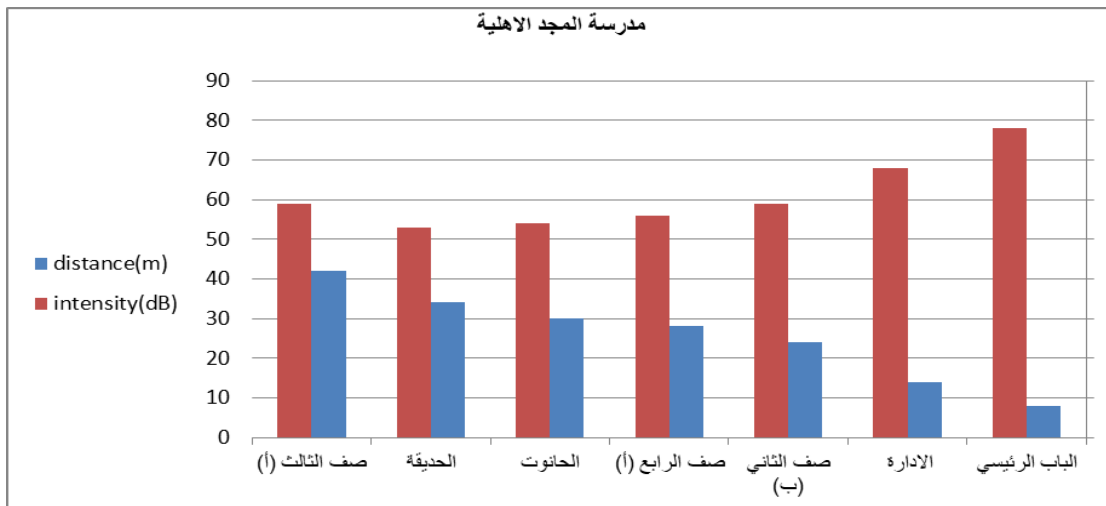
**4 The nerve of the inner ear** is called the auditory nerve, and It is the eighth cranial nerve. It has two branches: the first Is the cochlear nerve, whose fibers extend to the hair cells in the organ of corti, and the second Is the vestibular nerve, and Its fibers extend to the hair cells in the proximal, saccular, and tubercles of the semi-circular canals.[27]

### **3-1 Results and Discussion**

In Al-Majd Private School, the following readings were recorded and various distances were announced within the corridors of Al-Majd School, as mentioned in the table -1.



| location      | distance(m) | intensity(dB) |
|---------------|-------------|---------------|
| الباب الرئيسي | 8           | 78            |
| الادارة       | 14          | 68            |
| صف الثاني (ب) | 24          | 59            |
| صف الرابع (أ) | 28          | 56            |
| الحانوت       | 30          | 54            |
| الحديقة       | 34          | 53            |
| صف الثالث (أ) | 42          | 59            |



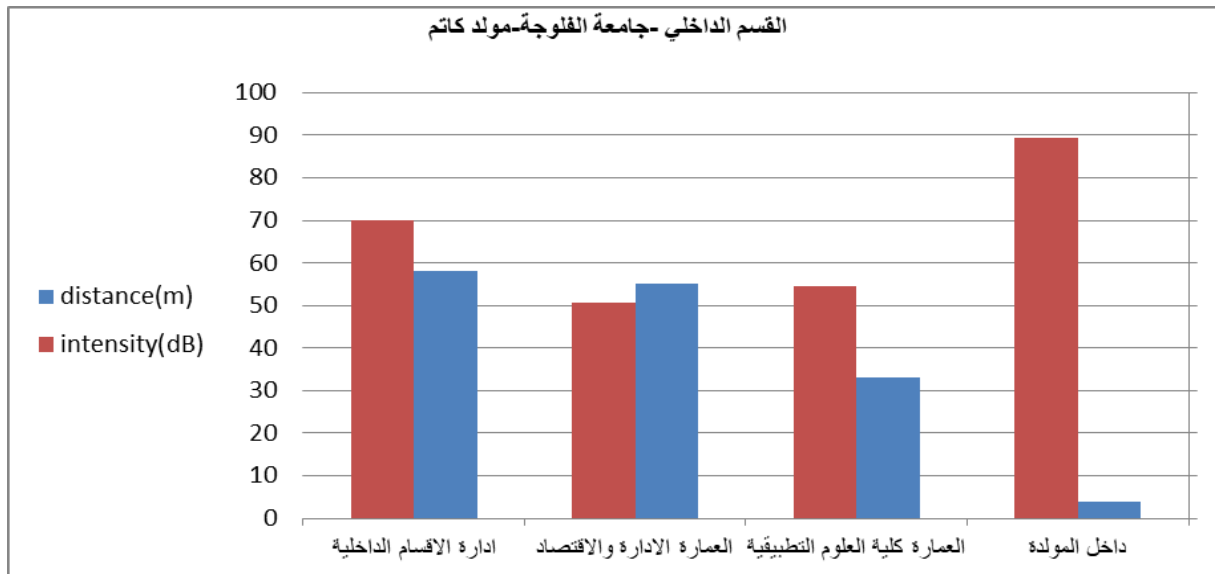
**Fig.1 : Relationship between average sound level intensity at several distances and location in Al-Majd School.**

The maximum duration of noise in Al Majd National School was measured at 78dB, due to the close distance to the electrical generator.

The lowest noise duration was measured at 53dB, which is due to the distance being far from the source of the generating noise.

In the internal departments, the following readings were recorded and various distances were announced within the corridors of the internal departments, as mentioned in the table -2.

| location                    | distance(m) | intensity(dB) |
|-----------------------------|-------------|---------------|
| داخل المولدة                | 4           | 89.3          |
| عمارة كلية العلوم التطبيقية | 33          | 54.6          |
| عمارة الادارة والاقتصاد     | 55          | 50.6          |
| ادارة الاقسام الداخلية      | 58          | 70            |



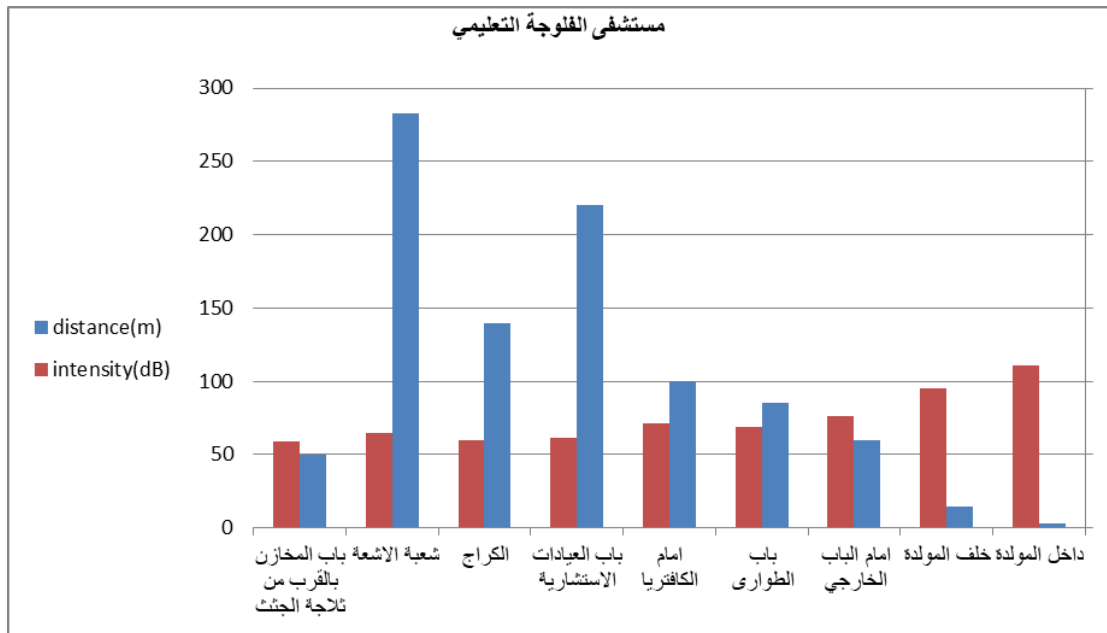
**Fig.2 : Relationship between average sound level intensity at several distances and location in internal departments.**

The maximum duration of noise in the internal sections was measured at 89.3dB, due to the close distance to the silent electric generator.

The lowest noise duration was measured at 50.6dB due to the distance from the generating noise source

At Fallujah Teaching Hospital, the following readings were recorded on different distances within the hospital corridors, as shown in the table -3

| location                | distance(m) | intensity(dB) |
|-------------------------|-------------|---------------|
| داخل المولدة            | 3           | 110.5         |
| خلف المولدة             | 15          | 95            |
| امام الباب الخارجي      | 60          | 76.5          |
| باب الطوارئ             | 85          | 69            |
| امام الكافتريا          | 100         | 71.3          |
| باب العيادات الاستشارية | 220         | 61.5          |
| الكراج                  | 140         | 60            |
| شعبة الاشعة             | 283         | 65            |
| باب المخازن الادوية     | 50          | 58.7          |

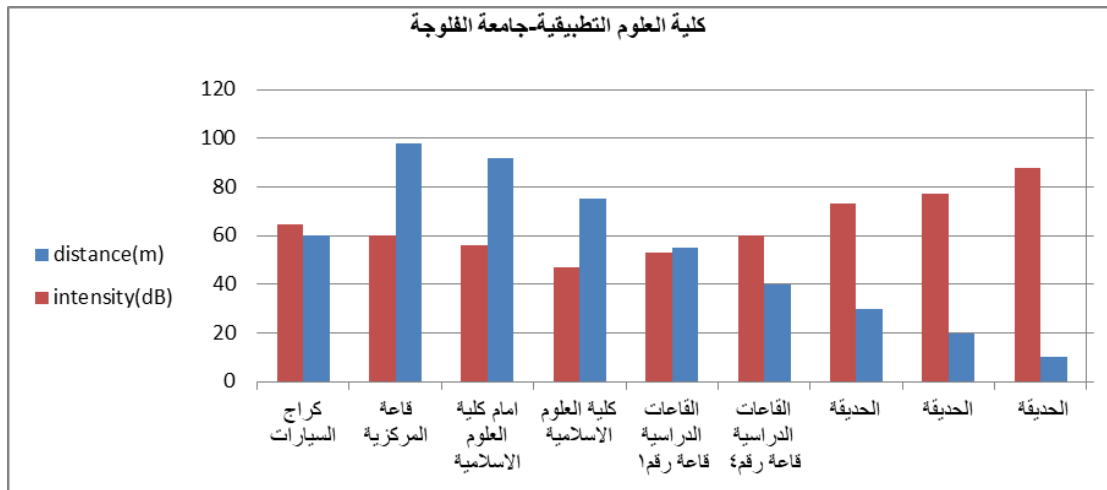


**Fig.3 : Relationship between average sound level intensity at several distances and location in Fallujah Teaching Hospital.**

The maximum noise in Fallujah Hospital was measured at 110dB due to the close distance to the electrical generator. The lowest noise duration of 58dB was measured due to the distance in the opposite direction of the generator

In the College of Applied Sciences, the following readings were recorded on different distances within the college corridors, as shown in the table -4

| location                    | distance(m) | intensity(dB) |
|-----------------------------|-------------|---------------|
| الحديقة                     | 10          | 88            |
| الحديقة                     | 20          | 77            |
| الحديقة                     | 30          | 73            |
| القاعات الدراسية قاعة رقم 4 | 40          | 60            |
| القاعات الدراسية قاعة رقم   | 55          | 53            |
| البنية الجديدة              | 75          | 47            |
| امام البنية الجديدة         | 92          | 56            |
| قاعة المركزية               | 98          | 60            |
| كراج السيارات               | 60          | 64.4          |



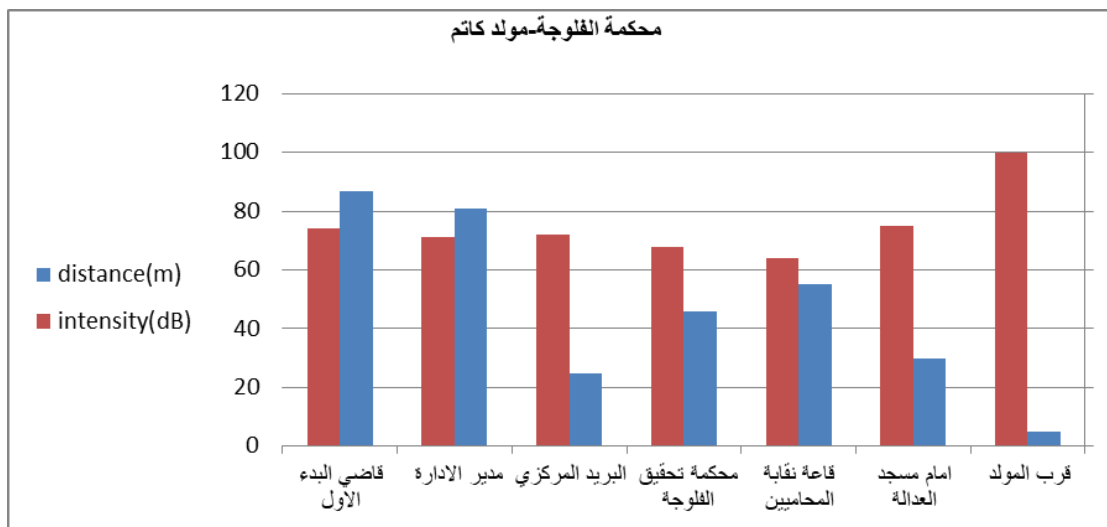
**Fig.4 : Relationship between average sound level intensity at several distances and location in College of Applied Sciences.**

The maximum noise duration measured in the College of Applied Sciences is 88dB due to the close distance to the electrical generator.

The lowest noise duration of 47dB was measured due to the long distance from the generating noise source

In the Fallujah Court, the following readings took place at different distances within the court's corridors, as shown in the table -5.

| location            | distance(m) | intensity(dB) |
|---------------------|-------------|---------------|
| قرب المولد          | 5           | 100           |
| امام مسجد العدالة   | 30          | 75            |
| قاعة نقابة المحامين | 55          | 64            |
| محكمة تحقيق الفلوجة | 46          | 68            |
| البريد المركزي      | 25          | 72            |
| مدير الادارة        | 81          | 71            |
| قاضي البدء الاول    | 87          | 74            |

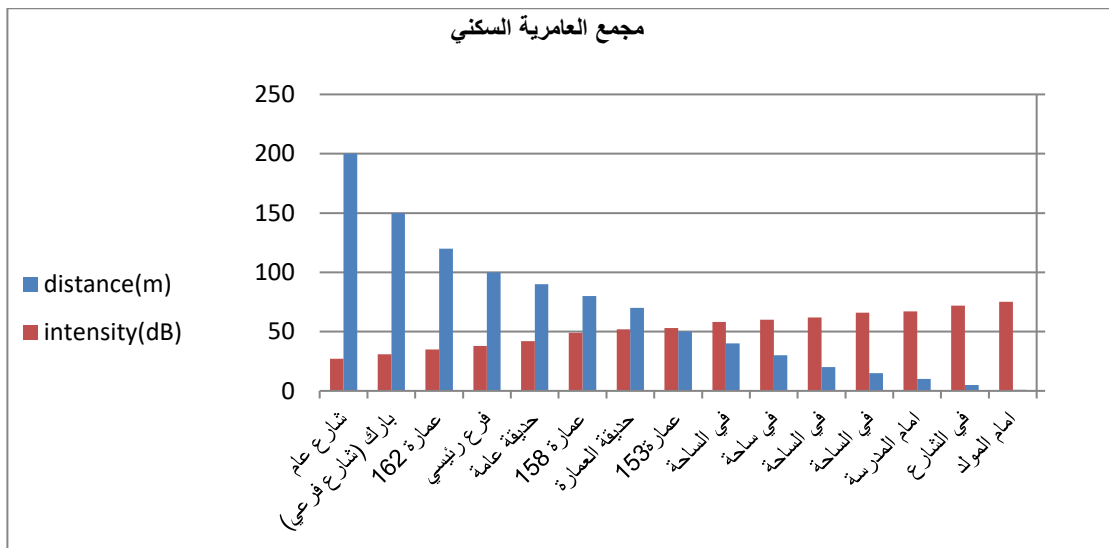


**Fig.5 : Relationship between average sound level intensity at several distances and location in Fallujah Court.**

The maximum noise duration in the Fallujah court was measured at 100, due to the close distance to the electrical generator The minimum noise duration was measured at 64, because of the distance it is far from the source of the generated noiseAs the distance increases, the intensity decreases

In the Amiriyat Al-Fallujah Complex, the following readings were recorded and different distances were announced within the corridors of the complex, as shown in the table -6.

| location         | distance(m) | intensity(dB) |
|------------------|-------------|---------------|
| امام المولد      | 1           | 75            |
| في الشارع        | 5           | 72            |
| امام المدرسة     | 10          | 67            |
| في الساحة        | 15          | 66            |
| في الساحة        | 20          | 62            |
| في ساحة          | 30          | 60            |
| في الساحة        | 40          | 58            |
| عمارة 153        | 50          | 53            |
| حديقة العمارة    | 70          | 52            |
| عمارة 158        | 80          | 49            |
| حديقة عامة       | 90          | 42            |
| فرع رئيسي        | 100         | 38            |
| عمارة 162        | 120         | 35            |
| بارك (شارع فرعي) | 150         | 31            |
| شارع عام         | 200         | 27            |



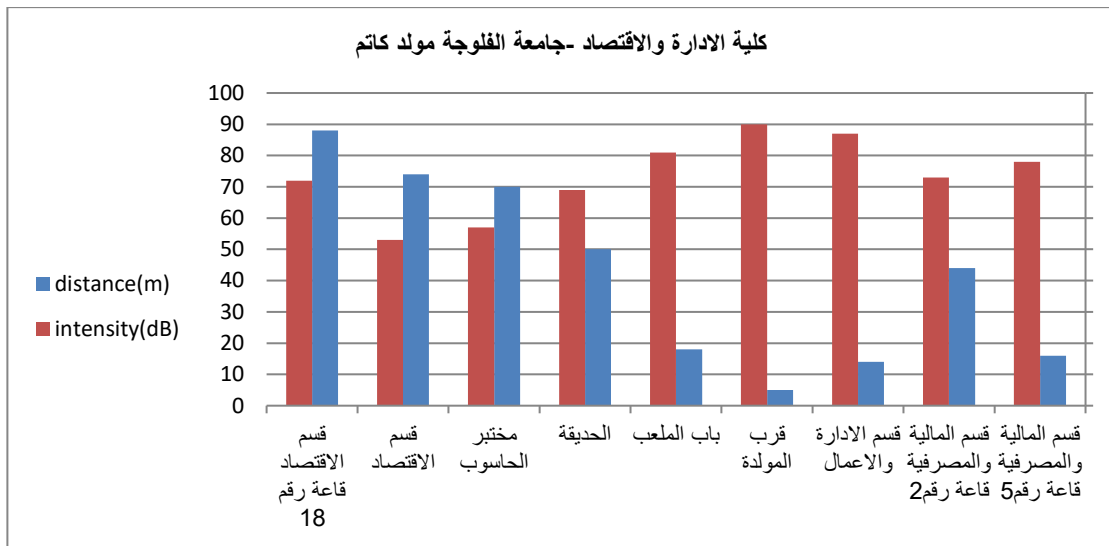
**Fig.6 : Relationship between average sound level intensity at several distances and location in Amiriyat Al-Fallujah Complex.**

The maximum duration of noise in the Amriya residential complex was measured at 75dB, due to the close distance to the electrical generator.

The lowest noise duration was measured at 27dB This is due to the long distance from the source of the generator's noise, and here a normal level appeared to us, which is 27dB due to the empty square.

At the College of Administration shown and Economics, the following readings were recorded and various distances were announced within the corridors of the college, as in the table -7.

| location                         | distance(m) | intensity(dB) |
|----------------------------------|-------------|---------------|
| قسم المالية والمصرفية قاعة رقم 5 | 16          | 78            |
| قسم المالية والمصرفية قاعة رقم 2 | 44          | 73            |
| قسم الادارة والاعمال             | 14          | 87            |
| قرب المولدة                      | 5           | 90            |
| باب الملعب                       | 18          | 81            |
| الحديقة                          | 50          | 69            |
| مختبر الحاسوب                    | 70          | 57            |
| قسم الاقتصاد                     | 74          | 53            |
| قسم الاقتصاد قاعة رقم 18         | 88          | 72            |



**Fig.7 : Relationship between average sound level intensity at several distances and location in College of Administration and Economics.**

The maximum duration of noise in the College of Business and Economics was measured at 90dB, due to the close distance to the electric generator. The lowest noise duration was measured at 53dB due to the distance away from the source of the generated noise

### **Suggestions**

#### **Solutions for noise from electric generators:**

##### **1. Reducing noise at the source:**

- Choosing a quiet electric generator:
- Look for generators rated for a low noise level (less than 70 decibels).
- Compare noise levels between different models before purchasing.
- Maintaining the generator periodically:
- Make sure all components are working properly.
- Replace worn or damaged parts.
- Check the engine oil level regularly.
- Use a silencer:



- Install a suitable muffler on the exhaust pipe.
- Make sure the muffler is suitable for the size and type of generator.
- Installing a soundproof barrier:
- Build a barrier around the generator from soundproof materials.
- Make sure the barrier covers all sides of the generator.

## **2. Reduce noise at the receiver:**

- Increase the distance between the generator and the workplace:
- The greater the distance, the less intense the noise.
- Try to place the generator away from populated places.
- Use earplugs:
- Earplugs can significantly reduce the noise level.
- Make sure to use earplugs that fit the appropriate ear size.
- Planting trees and plants:
- Trees and plants can help absorb noise.
- Plant trees around the generator or in the surrounding area.

## **3. other solutions:**

- Using a backup generator:
- Use a small generator to power only necessary appliances.
- This will reduce the noise from the main generator.
- Switching to alternative energy sources:
- Use solar or wind energy to generate electricity.
- These sources do not produce any noise.

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