

# The Effect of Using Noise Barriers on the Urban Appearance in Cities: Insights from residential complexes in Baghdad, Iraq

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## Abstract

*This research examines the effect of using noise barriers in cities. It is problematized that there is a cognitive deficiency in determining the indicators that achieve compatibility between the types and forms of noise barriers that can be used on the borders of residential complexes with the urban scene of the street in particular, and the city in general. The research aim is to extract a set of indicators through which it is possible to determine the types and forms of noise barriers that correspond to the elements of the appropriate scene for the city. For this purpose, it adopts indicators extracted from previous research to determine the forms and types of sound barriers used on the boundaries of residential complexes in Baghdad. It concludes that it is possible to select the types and forms of noise barriers that are compatible with the elements of the urban scene suitable for the city through a set of indicators. It also concludes that they do not negatively affect the general scene of the city, but have a positive impact on the urban scene if they are subject to these indicators.*

**Keywords:** Sound, Noise, Noise Barriers, Visual Pollution.

## Introduction

Cities are characterized by many urban, cultural and artistic characteristics, and the most prominent thing that reflects these characteristics is the urban scene of these cities. It represents a complex urban form whose components overlap and intertwine. The urban scene represents a medium in which there are many elements and components, including sound as it represents one of the forms of energy. The group of sounds of different frequencies that are not suitable for human hearing is considered noise, which causes discomfort to the recipients and sometimes causes pain.

For the purpose of reducing noise and its negative effects in cities, this study aims to investigate the possibility of using one of the most prominent globally approved methods: noise barriers in a positive way in the urban scene without negatively affecting it.

Accordingly, in this research, the impact of the use of noise barriers on the urban scene of the city was studied. It adopted indicators extracted from previous research to choose the forms and types of barriers to ensure they do not negatively affect the general view of the city if we assign them on the borders of residential complexes in the city of Baghdad.

In the study, we combine the most important types and designs of possible forms of noise barriers and apply them in a three-dimensional format on a selected group of residential complexes on the borders of the city of Baghdad with the most important indicators of the components of the urban landscape suitable for the city. It seeks the assistance of a group of specialized experts to survey their opinions about these forms and types and the extent of their impact on the urban landscape of the city in order to achieve the goal of the research, and to conclude which types were the best and most appropriate in terms of shape, design, etc.

The barriers were not taken as a variable as a whole, but only in terms of their forms, as different types and shapes (designs) were used, to test their impact on the landscape from an aesthetic point of view. We did not study its type functionally, as the ratio of noise reduction is not a variable in the search, and that any kind would be better than none.

There are many local and foreign studies that dealt with the concept of noise, and here we examined some of them. They are summarized in tables 1 and 2. They show an analysis of these studies according to the direction of the research regarding the use of the noise barriers mechanism to reduce noise and the aspects covered.

**Table 1:** Analysis of local studies that dealt with the concept of noise.  
Source: Author

Study	Title	The type of noise the research involved	The direction of the research regarding the use of the noise barriers mechanism to reduce noise	The aspect covered by the research
Al-Samarrai , 1987	The effect of traffic noise on some residential areas of the city of Baghdad	Traffic noise	The study calls for the use of noise barriers in highways as it is one of the effective ways to block traffic noise, provided that these barriers have a sound absorption capacity of no less than an absorption coefficient of (0.6) and be able to withstand wind pressure.	Functional aspect
Ahmed , 1989	Noise from external sources in residential buildings	Environmental noise (internal and external)	1. Calling for the use of acoustic barriers separating residential blocks from the public street. 2. The necessity of placing wall barriers on both sides of the streets of the highway traffic inside the city, and that the barriers are tilted at an angle of (15) to repel the noise to the outside.	Functional aspect
Abdul-Qadir , 1990	The effect of the formal components of the urban blocks on the noise level of the residential neighborhood	Traffic noise	-----	----
Attia , 1991	The effect of the formal characteristics of the space organization within the residential neighborhood on the level of traffic noise	Traffic noise	Advocate the use of noise barriers as a mechanism that can be used to control the noise transmission medium.	Functional aspect
Mohammed , 2011	The effect of using the theory of barriers to reduce the level of internal noise in the factory in raising the efficiency of performance	Internal noise (machines and machinery noise)	For the (internal) barriers has a role in reducing the noise generated in the internal environment of the laboratory and increasing the performance efficiency of the working individual.	Functional aspect
Hussein , 2017	The impact of advertising signs on the urban scene of city centers	Visual noise	-----	----

**Table 2:** Analysis of foreign studies that dealt with the concept of noise.

Source: Author

Study	Title	The type of noise the research involved	The direction of the research regarding the use of the noise barriers mechanism to reduce noise	The aspect covered by the research
Jean , 2000 (France)	The Effect of Structural Elasticity on the Efficiency of Noise Barriers	Traffic noise	]Directing the need to use barriers of all kinds, as new designs of barriers constantly appear as attempts to improve: cost, efficiency, and design..	Functional aspect (performance efficiency comparison)
Bowker et al, 2007 (USA)	The effects of roadside structures on the transport and dispersion of ultrafine particles from highways	Environmental noise	Call for further research to determine the effects of barriers under changing wind conditions and topography..	Environmental aspect
Adhikari et al, 2020 (Nepal)	Noise Control in Residential Buildings.	Indoor noise of all kinds (sound pollution)	The barrier mechanism is most effective when noise sources such as highways are near a pre-existing community	Environmental aspect (healthy)
Jiang et al, 2016 (China)	Combined acoustical and visual performance of noise barriers in mitigating the environmental impact of motorways.	Environmental + Audio + Visual noise	Concluding that there is a significant positive relationship between the aesthetic preference for barriers and the reduction of environmental impact through barriers in residential areas	Environmental + Functional + Aesthetic Aspects
Alam et al, 2020 (India)	"3D noise mapping for preselected locations of urban area with and without noise barriers, A case study of Delhi, India"	Traffic noise	Noise barriers play a vital role in reducing noise significantly	Environmental functional aspect
Yeung , 2020 (Hong Kong)	Application of Green wall panels in Noise Barriers.	Traffic noise	1. Building and modifying noise barriers is a necessary need to maintain the quality of life of people who live, work or study near busy traffic roads 2. Consider designing noise barriers so as to visually coincide with the vicinity to avoid an ugly scene.	Functional + Aesthetic Aspects

Furthermore, there are many previous studies that dealt with the concept of urban scene. The research involved some of these studies summarized in tables 3 and 4.

**Table 3:** Analysis of local studies that dealt with the concept of urban scene.

Source: Author

Study	Title	The main indicators and elements of the urban scene extracted from the study	Urban scene relations
Elias , 1989	The urban scene and its impact on the urban renewal criteria of the traditional fabric	Optical density, homogeneity and continuity, scale, proportion, solidity and space, facade lines, building height and skyline, building line, materials and details, width of building unit, recurrence	Alignment Integration Unity
Al-Mubarak , 1999	Cohesion and disintegration in the architecture of the	Attempting to achieve aesthetic satisfaction and visual and psychological pleasure by using formal relationships and aesthetic supplements	Harmony, homogeneity, visual continuity

	urban scene of the contemporary city		
Al-Aqili , 2003	"The Impact of the Great Mosque on the Urban scene of the City"	Context and semantic elements within the part that affect the urban scene , Landmarks, path axis, signs	----
Rassam , 2004	The impact of addition and its original presence in the urban scene	Inclusion, composition, genitive relationship to the origin, dominant visual axis, and regularity. Elements: Landmarks - Landmarks - Paths	Relationship of the position of the addition to the original Spatial relationships
Hefta , 2014	Study of the elements of the architectural and urban scene	Vitality, subjective behavior, visual adequacy, induction, permeability,	Linking elements with physical or sensory relationships

**Table 4:** Analysis of global studies that dealt with the concept of urban scene .

Source: Author

Study	Title	The components of the urban scene extracted from the study	The cultural component of the scene	The physical component of the scene
Cullen , 1961	"The Concise Townscape"	- Natural Elements - the art of relationships - Man-made elements	Integration of elements of the urban scene as a whole	Different treatments: scale, pattern, detail, color and texture
Spreiregen , 1965	"Urban Design: The Architecture of Towns and Cities"	* Physical Components * Spaces * Activities * Motion Systems	Impression Experiments Memories	Considerations of physical appearance and properties of building shapes, density of buildings, relationships, materials
McCluskey , 1979	"Road Form and Townscap"	Intersections, line - path axis, width - street width, introduction - suspended structures, landmarks, containment	Components have several levels ranging from the surface level to the deep level, which have visual and psychological effects on the recipient	
Tugnett et al, 1987	"Making Townscape"	* The broader context (the city as it is, its historical pattern, and its current structure. * Local context (street scene and adjacent spaces	Context	Elements
Broadbent , 1990	Emerging concepts in urban design"	*Physical components * Civilization components	The meaning	Age, size, color, design, shape, building materials, construction condition
Punter et al, 1997	"The Design dimension of planning, theory, content and best practice for design policies"	Visual relations between the totals of buildings that make up the urban plan	Visual relations (considerations of appearance, block shapes, scale, and morphology)	-----
Aminzadeh , 2010	"Developing Urban Design Aesthetic Criteria Based on Users Preferences"	The study considered that the scene is a context composed of parts	Context Memories	-----

Above analysis shows that there is an absence of accurate and comprehensive cognitive views in determining the indicators for the appropriate urban scene, which can be adopted to determine the types and forms of noise barriers that if used in the urban scene, it wouldn't negatively affect it. From here, the research question was formed as follows.

Is it possible to determine the types and forms of noise barriers to be used on the borders of residential complexes in the city of Baghdad without negatively affecting the street scene particularly, and the urban scene of the city generally?

The research problem has been identified as “there is a cognitive deficiency in determining the indicators that achieve compatibility between the types and forms of noise barriers that can be used on the borders of residential complexes to reduce noise with the urban scene suitable for the street in particular and the city in general”.

Moreover, this research assumed that, it is possible to determine the types and forms of noise barriers that correspond to the elements of the urban scene suitable for the city through a set of indicators. In view of the research problem and its hypothesis, the goal of the research was determined as “extracting a set of indicators through which it is possible to determine the types and forms of noise barriers that correspond to the elements of the appropriate scene for the city”.

## The Theoretical Basis

### Sound:

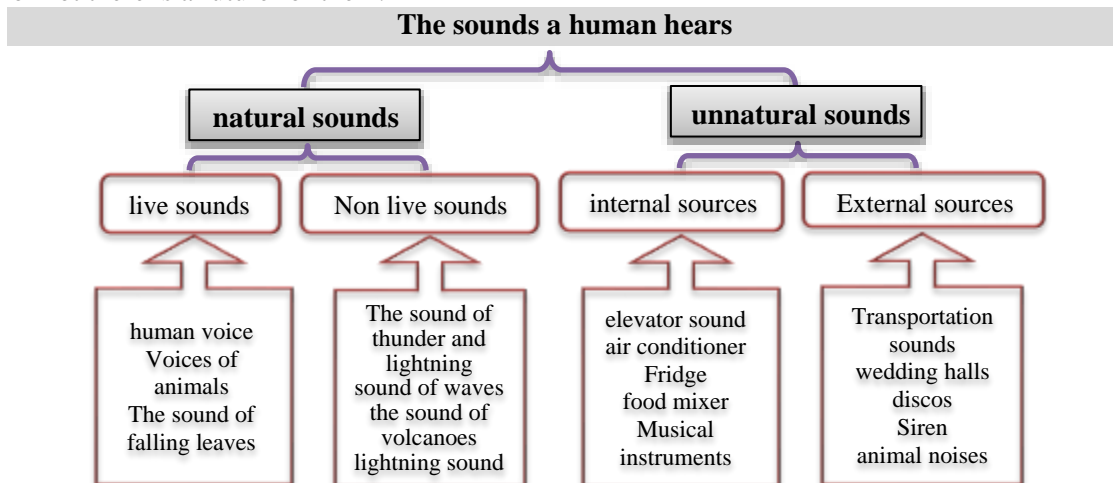
Sound is a form of energy. It is transmitted from one place to another by mechanical waves and pressure waves that cause vibrations in the air or building materials, and it is measured in microbars.

To generate sound, three elements are needed (Bane-Karash, 2015).

- 1- An audio source
- 2- Medium to move it.
- 3- Receiver to receive it

Sound has two meanings:

The first is physiological because the perception of sound depends on the ability of the nervous system to receive and analyze it, and there are sounds that humans cannot hear. The second is physical and means that those waves that are known by sound, regardless of whether or not there is a future for them.



**Fig. 1:** Classification of the Sounds a Human hears.

Source: Author

The sound has characteristics that distinguish it, which are:

1. Sound Degree: the distance at which sound from an audio source can be heard.

2. **Sound Intensity:** the amount of energy working to transmit sound waves from the sound source to the ear of the listener, as the loudspeaker works to increase the density of sound particles in order to reach farther places.
3. **Sound Quality:** It is the measure used to determine the clarity and purity of the sound reaching the listener.
4. **Sound Wavelength:** The distance between two peaks or troughs in two successive waves of sound waves.
5. **Amplitude (the amplitude of the sound wave):** The strength of the wave signal emitted by the sound source, and it is represented on the graph by the height of the wavelength. The higher the height, the greater the amplitude of the wave, and thus the higher the sound.
6. **Frequency:** It is defined as the number of sound waves that exceed a point during a period of time measured in seconds, and the unit of measurement for frequency is the hertz and its multiples. It is also defined as "the number of changes per second due to the transmission of sound in the air in the form of longitudinal waves characterized by compression and volumetric rarefaction and in an elastic material medium. It is measured in HZ". (Ahmed, 1989)
7. **Speed of sound:** the speed at which sound travels in a material medium. It is the speed of sound waves emitted from the sound source to the human ear, and these speeds vary according to the type of material medium. (previous source)

The shape of sound is determined by two characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound pressure difference, and frequency is how many times the sum of the differences are repeated per second. And it is through these two characteristics, that the shape and strength of the sound wave are determined. (Al-Samarrai, 1987)

### **Noise:**

Noise is a term used to describe sounds of undesired nature. Noise represents a type of physical environmental pollution because of its damages to the physiological and psychological health of human beings and in generating diseases related to the nervous system, heart and arteries, including auditory fatigue as well as pathological deafness (Mohammed, 2011).

Noise, in a general sense, is a group of sounds of different frequencies that are not suitable for human hearing and cause discomfort and excitement and may sometimes cause pain. (Abdul Qadir, 1990). In fact, noise represents energy waste, and unlike other types of environmental pollution that are feared to accumulate, it is instantaneous and dissipative, and its effect is limited only when it is emitted and disappears immediately with the demise of the source. This type of pollution takes the form of sound waves that are transmitted in different media, especially in the air, in the form of pulses of high and low pressure in the carrier medium, which is caused originally by the oscillation of a body (Al-Bahrani, 2009).

The amount of noise disturbance depends on:

- a- The frequency of the noise.
- b- The distance of the noise source from the receiving point.

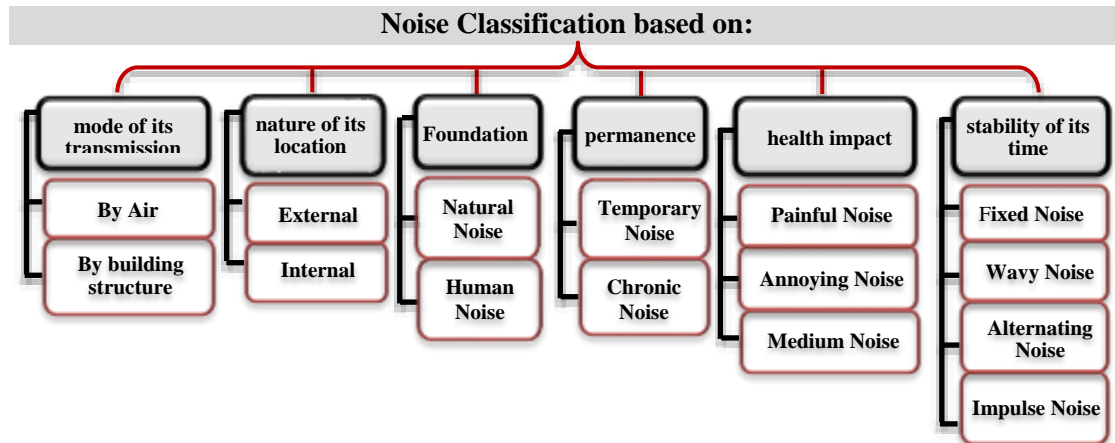
Noise is measured in decibels (dB) and (78) decibels is the maximum sound level allowed for humans according to some international organizations.

The measurement of the noise level depends on (Musa, 2006)

- 1- Sound pressure: which is expressed in units of pressure measurement (millibar and its parts), and when it is doubled, it will lead to an increase in the noise level.
- 2- Sound intensity: the amount of sound energy that travels through a unit distance from the medium per unit time, and expresses the depth of the sound wave and its effect on the sense of hearing.

Noise has different types depending on many influences, which are summarized as follows:





**Fig. 2 :** Types of Noise  
Source: Author

### Noise Barriers:

Barriers are the obstacles placed between the sound source and the receiver, and to be effective, the height of the barrier must cover the line of sight between them (Fleming et al, 1992). A sound barrier represents the rate of loss of the transmitted sounds (Sound Transmission Loss).

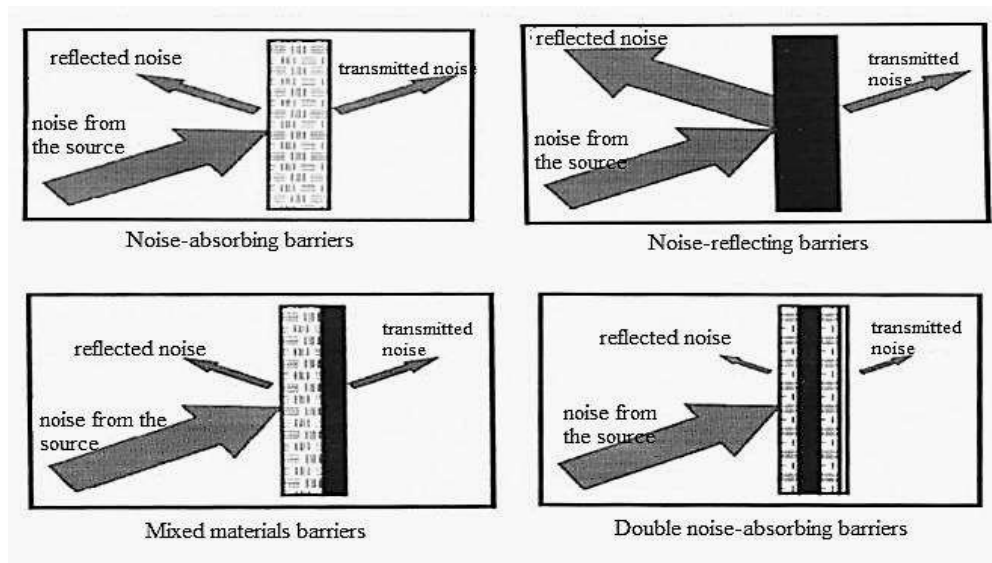
It is defined as the difference between the turbulent noise level of the barrier and the level transmitted to and from the other side of the barrier. It is also possible to compare the various barriers using the rate of "sound transmission loss (STL)" for the transmission of sound (Mohammed, 2011).

Barriers and obstacles are used to separate automated traffic from pedestrians, and this does not prevent the presence of aesthetic functions for them (Mohammed, 2015).

### Types of Noise Barriers:

Noise barriers can be classified according to the way they are installed and deal with the noise coming to them and the mechanism of absorbing this noise into the following types (Mohammed, 2011). See Fig. 3

- A. Noise-reflecting barriers: These types of barriers are characterized by not absorbing noise, but rather dissipating or spreading it. If these barriers are misused, they may leave negative effects, as according to the reflected noise, noise levels can increase from the noise source located next to the barrier, which can create effects called the sound box.
- B. Noise-absorbing barriers: Noise-absorbing barriers reduce the reflection of sounds or the so-called echo and disperse the noise force and work to suppress it, and may allow the transmission of some noise depending on its continuous quantity. The transmission of noise depends on the physical strength of the barriers, which must be made of materials of good quality. The basis or rate of the effectiveness of the absorbing barriers depends on the amount of absorbed noise compared to the noise level from the source.
- C. Double noise-absorbing barriers: These barriers consist of two layers of noise-absorbing materials, and these barriers are usually effective when used in high-frequency machine rooms, through the generation of the so-called sound box.
- D. Mixed materials barriers: These barriers consist of a block of composite materials, which work to reduce noise reflections. The physical strength, method of insulation, acoustic compatibility, and durability are among the most important factors involved in achieving the required reduction in the noise level for each of the two materials (barrier and absorbent) that make up these barriers.



**Fig. 3:** Types of Noise Barriers

Source: Author

### Installation of Noise Barriers:

It is possible to use different materials in the installation of the acoustic barrier for noise in an unlimited way, and in general the following materials can be used (Ibrahim, 2010).

- A. **Concrete:** Concrete is used in several ways in noise barriers, and its most important benefits are that it is easy in terms of installation and maintenance, and artistic and decorative formations can be made to give aesthetics to its facades. At the same time, it reflects the rays falling on it in the directions designed or required to be directed to it.
- B. **Metal:** Metal barriers (such as made of iron) are used and covered with noise-absorbing materials such as fiberglass and glass wool to reduce noise. Aluminum is also used because of its durability and light weight. An aluminum plate with a large area can be used and fixed with a few brackets (maximum dimension is 5 meters)
- C. **Transparent materials:** where transparent materials allow lighting or light to penetrate through them to the spaces or buildings located behind the barriers made of them or in their shade area. It is considered a noise reflective material. It also has negatives represented in its concentration of temperatures and the need for continuous maintenance.
- D. **Recyclable materials:** plastic materials after being recycled can be used in structures for noise-absorbing panels, and they can also be colored in colors different from their original colors to give them an appearance that distinguishes them from their previous use.
- E. **Dam and earthen mounds:** It is the surplus materials resulting from road constructions, and most of them are earthy materials. It has a small cost if it is used for noise isolation purposes, and it can be economical in terms of not having to transfer from other places. The design of mounds or earthen embankments should take into account the area around the site.
- F. **Planted barriers:** They are called green barriers because they use evergreen trees, and they are usually used with dictates of soil that sometimes reach four meters in height. This type of barrier requires constant care for these plants, especially in dry climates, where they need continuous irrigation, and they also need to control harmful insects, to preserve them and maintain their visual impact. It also sometimes requires soil maintenance and replacement of damaged parts.

### The Urban Scene:



Scene means: a part of the field, directly seen from a certain observation point. A scene is the spatial arrangement and visual appearance of buildings and green areas when viewed from outer space. It reflects the lifestyle of individuals, which appears to the eye from the urban structure and the feelings interact with it, and it represents the manner in which the elements are organized within the urban context and which defines its visual characteristics (Hammoud et al,2015).

The scene consists of entities (elements) that organize and interact with each other to reflect the culture of the community of this scene, and they are of two types:

1. Natural entities, such as: (Terrain units, water network, soil, etc.).
2. Unnatural - manufactured entities, such as: (residential buildings, industrial facilities, road networks, and others).

Scenes according to their nature can be distinguished into two main types:

- A. The urban scene.
- B. The rural scene.

### Definition of the Urban Scene

The urban scene of a city emerges to the recipient in the form of a series of images and scenes during the movement, which is called the “sequential vision”, as the urban scene is basically built on the sequential vision realized from movement in the paths and roads.

The urban scene is generally defined as the organization of the elements and components of the physical environment of the city, leading to an integrated sensory image that gives the city its character and identity based on a set of design and organizational determinants and visual activities (Al-Samarrai, 2006).

Research has indicated that there are many and varied definitions of the concept of urban scene that do not differ in essence in expressing it, and that their difference is only in giving a comprehensive picture of the elements and components of that scene. (See table 5).

Thus, the urban scene can be defined procedurally as a spatial formation, arrangement and organization of the perceptible elements of the urban structure. It is the art of creating an integrated view and vision of the effects through mass and spatial processes and interconnections, which differ from one environment to another according to the nature of the society that builds its urban scene, and thus it is an attempt to form an image. It constitutes a totality of the built environment that the eye sees to create an integrated sensory image distinct with its own identity from other environments.

**Table 5:** Definition of studies to the urban scene

Source: Author

Study	Definition of the Urban Scene	The Nature of the Definition
Cullen, (1961)	It is the art of giving coherence and visual organization to the mixture of buildings, spaces and streets that make up the urban structure.	Perception of the scene
Megerson, (1963)	It is a visual impression of all the elements and components of the city, as it is affected by a set of fixed and changing factors that affect in the entity of the city.	Perception of the scene
Ward, (1968)	It is an organization of the elements of the physical environment in the city, which crystallizes the urban image and the integrated sensory relations between the elements, giving the city its identity and distinct urban character.	Reality of the scene
Younge, (1977)	It is what contains buildings, trees, gardens, sky, water, colors, buildings, surfaces and floors, as it represents a three-dimensional phenomenon surrounding us that we move in and through.	Reality of the scene
Tucker et al, (2005)	It is the spatial arrangement and visual appearance of the built and green formations when viewed from outer space.	Reality of the scene

### Components of the Urban Scene

The image of the urban scene is based on (Al-Baloury, 1997):

- The general structure of the city.
- General Urban Authority (Urban Form).

- The relationships between the elements of the urban scene.
- Space organization.
- Individual characteristics.

The main components of the urban scene are divided into:

- A. Physical components.
- B. Intellectual components (humanity).

These components pave the way for creating the meanings of the urban environment through interaction and dialogue with each other to formulate an urban space system in a natural dramatic framework (Awda, 2007).

The physical components of the urban scene are classified into two levels: the first relates to the holistic body (the whole), and the second relates to the parts. (See table 6)

**Table 6:** Physical components of the urban scene

Source: Author

Physical components	
at the level of (Parts)	at the level of (All)
walls	body (figure)
Materials, colors, textures	the size
Doors and Windows website	urban scale
Details, individual characteristics	Architectural style
Openings, protrusions	directivity
Horizontal divisions, vertical divisions	flooring

The components of the urban scene are also divided into fixed and variable components:

- A- Fixed components: They are the ones that have physical properties, and have mathematical properties, which gives them the attribute of stability and immutability. Such as point, line, surface, volume, and space.
- B- Variable components: They are the ones that have variable and unstable properties and qualities. Such as texture, color, light, movement, time, attractions.

The nature of the relationships between these components is what influences the shape of the scene and defines its urban identity that distinguishes it from any other scene.

Relationships represent: a set of guidelines, by which fixed and variable components are used and linked in order to achieve an architectural product that represents a physical form that has an intellectual content. Thus, it represents the mechanism of transforming ideas into material forms, and considering the two as two independent phenomena.

Relationships aim to achieve concepts: balance, proportion, dominance, contrast, harmony, unity, rhythm, composition - grouping of elements, symmetry. Those concepts in total represent the main indicators of aesthetic relations in the urban scene.



**Fig. 4:** Relationships between the elements of the urban scene

Source: Author

## Environment

The environment is a series of relationships between people and elements, and these relationships are regular, have a pattern, have a structure, and are not a random assemblage of things (Rapoport, 1977).

## Urban Environment

It is a series of organized relationships with a specific pattern between humans and physical elements, where there are related relationships in the urban environment (relationships affected by urban organization) that reflect the relationship between people and elements of the environment that affect human behavior through his perception of the environment (Kawthar, 2009).

## Visual Pollution

It is a distortion of any view that the eye falls on, and the person feels uncomfortable when looking at it. It is described as a type of artistic lack of taste that causes the disappearance of the aesthetic image of everything. The visual coexistence of the human being usually plays a key role in directing his behavior, and these behaviors are reflected as a result of the accumulation and deposits of the surrounding environment that lacks aesthetics, and only what is not common in its atmosphere Beautiful and inconsistent or homogeneous. In sum, it represents a negative reflection on society, as the lack of beauty gradually leads to the corruption of public taste as a result of the accustomedness and prevalence of ugliness (Ibrahim, 2007).

## Effect of Noise Barriers on the Urban Environment and Scene

Noise barriers are architectural features in their own right and must be designed to suit their local environments. If these barriers are not designed for each individual site, they are likely to remain boring and uninventive visuals that reduce the character of the scene and the quality of the surrounding scenes (Alberts et al., 2017)

Noise barriers are consider one of the most reasonable and available measures to mitigate noise intensity and its impact on the receiver. Noise barriers on the side of the road can affect the aesthetic perception of both: road users and residents. The visual impact of the barriers on neighboring communities and on motorists is a key consideration in the design of roadside barriers. (Kotzen & English, 2014)

The general appearance of noise barriers is further clarified through the application of architectural concepts such as a. percussion, b. ratio, c. system, d. harmony, e. variance. (no priority for ranking).

Noise barriers must be designed with an appropriate scale and character compatible with the local environment. If it is not possible to design a barrier that integrates with the local environment, the goal must be to reflect some of its features such as: materials, colors, textures and shapes, in the form of barriers that are aesthetically attractive without being dominant on the field of view.

Finally, elements were extracted to achieve the aesthetic aspect of the noise barrier; i.e., indicators of aesthetic elements of noise barriers. Those include the following:

1. Architectural form.
2. Visual impact.
3. Compatibility with local features.
4. Coordination with street furniture and elements.

Indicators have also been extracted that will evaluate the urban scene in a direction that makes it more suitable for the city, which are the indicators of adequate urban scene. They include :

1. Quality of sense of place.
2. The comprehensive visual perception of it.
3. The visual unity.
4. The visual integration.
5. The mental image generated.

## Methodology

Five models of noise barriers were designed for each of the selected study areas, where five hypothetical models of barriers were proposed in each of the study areas, and each model

was designed in a different shape and type from the other. Then assessing the quality of each form by designing a questionnaire and distributing it to the respondents.

The model of questionnaire consisted of three paragraphs:

- 1- Indicators of the appropriate urban scene,
- 2- Indicators of the aesthetic relations of the urban scene,
- 3- Indicators of the aesthetic elements of noise barriers.

On the basis of these indicators, this research tested the effect of the model of barrier on the urban scene.

The results of the questionnaire for the three paragraphs of each model were collected. They indicated which models are the best and which are the worst in achieving the indicators, after calculating the average values of the secondary indicators branching from them and obtaining their percentages.

At the end, we calculated the average percentage of the three indicators together and obtained a comprehensive percentage of the extent to which each model achieved it.

### The Case Study: Baghdad City

The study areas included five residential complexes because they are located on the main traffic arteries of the city of Baghdad, and because they suffer from heavy traffic noise. And the names of these residential complexes are:

- 1- Al-Salhiya Residential Complex.
- 2- Al-Salam Residential Complex.
- 3- The Dutch Buildings in Haifa Street.
- 4- The Korean Buildings in Haifa Street.
- 5- Al-Saydiyah Residential Complex.

### The Suggested Models of Noise Barriers for the Case Study Areas:



**Fig. 5:** Suggested Barriers Models for Area (1)  
Source: Author



**Fig. 6:** Suggested Barriers Models for Area (2)  
Source: Author



Model 1

Model 2

Model 3

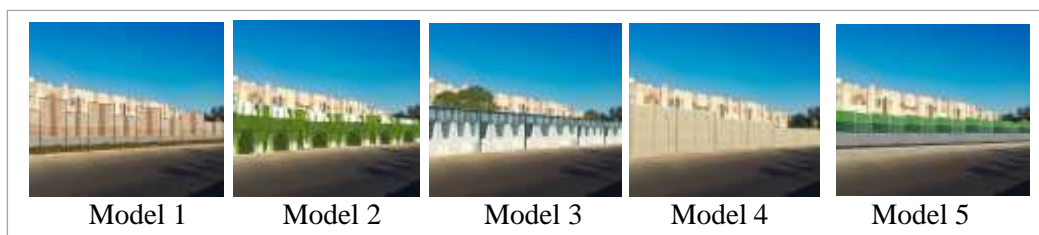
Model 4

Model 5

**Fig. 7: Suggested Barriers Models for Area (3)**  
Source: Author



**Fig. 8: Suggested Barriers Models for Area (4)**  
Source: Author



**Fig. 9: Suggested Barriers Models for Area (5)**  
Source: Author

## Results

Five hypothetical models of noise barriers have been proposed in each of the areas selected for the study, so that each model has a different shape and type from the other.

In the study area (1): the first model was designed from wood material, the second model was made of wood and glass, the third model was made of concrete and glass, the fourth model was made of a green plant wall with a supporting structure, and the fifth model was made of metal with transparent glass panels. Refer to Fig. 5.

In study area (2): the first model was designed from aluminum, the second model was made of metal and glass, the third model was made of concrete, and the fourth model was designed from a plant wall (climbers) with a supporting structure filled with dirt, and the fifth model was designed from the wood. Refer to Fig. 6.

In study area (3): the first model was made of concrete and glass, the second model of concrete reinforced with plants, the third model of precast concrete slabs, the fourth model was a green plant barrier, and the fifth model was glass. Fig. 7.

In the study area (4): first model is designed from metal and glass, the second model is made of concrete, the third model is made of wood and plants, the fourth model is made of metal, and the fifth model is made of a plant supported by a structure. See Fig. 8.

Finally, in the study area (5): the first model was designed of wood, the second model of a concrete wall reinforced with plants, the third model of bricks and glass, the fourth model was designed from concrete, and the fifth model was designed from metal. see Fig. 9.

Then, after the questionnaires were collected and the questionnaire results were calculated for the three paragraphs of each model, we calculated the average percentage of the three indicators together and obtained a comprehensive percentage of the extent to which each barrier had achieved the three concepts. It determined which model were the best and which



were the worst in achieving the requirements of the indicators in the specific study area. See table (7)

The results of each study area were sorted separately based on the results of the questionnaire for each case. Afterwards, on the basis of these a set of conclusions were reached, which are shown as follows.

In case study (1) the result was:

- The best model that achieved indicators in the study area (1) with the highest percentage is the fourth model (designed from a green wall with a supporting structure "vegetable barrier").
- The worst model in achieving indicators is the fifth model (from metal and glass).

In the case study (2) the result was:

- The best model that achieved the indicators in the study area (2) is the fourth model (from a plant wall with a supporting structure filled with soil).
- The worst model in achieving the three indicators is the first model (aluminum and glass).

In case study (3) the result was:

- The best model that achieved indicators in the study area (3) with the highest percentage is the second model (designed from a concrete wall supported by plants).
- The worst model in achieving indicators is the third model (designed from precast concrete).

In case study (4) the result was:

- The best model that achieved indicators in region (4) with the highest percentage is the fifth model (designed from a plant wall supported by a structure).
- The worst model in achieving indicators is the fourth model (from metal and glass).

In case study (5) the result was:

- The best model that achieved the indicators in the study area (5) with the highest percentage is the second model designed from a concrete wall reinforced with plants.
- The worst model in achieving indicators is the fifth model (designed from metal).

**Table 7:** The Results (Average ratios of the three indicators of the proposed barriers models in The Case Study)

Source: Author

Al-Salhiya residential complex	Evaluation the quality of the model according to the appropriate urban scene indicators	Evaluation the quality of the model according to the indicators of aesthetic relations in the urban scene	Evaluation the quality of the model according to the indicators of the aesthetic elements of noise barriers	Average rating for all indicators at each model
Model 1	71%	73%	76%	73%
Model 2	72%	78%		75%
Model 3	65%	69%	65%	66%
Model 4	86%	86%	87%	86%
Model 5	66%	63%	63%	64%
Al-Salam residential complex	Evaluation the quality of the model according to the appropriate urban scene indicators	Evaluation the quality of the model according to the indicators of aesthetic relations in the urban scene	Evaluation the quality of the model according to the indicators of the aesthetic elements of noise barriers	Average rating for all indicators at each model
Model 1	63%	62%	62%	62%
Model 2	65%	66%	64%	65%
Model 3	66%	73%	73%	70%
Model 4	79%	82%	82%	80%
Model 5	63%	65%	65%	64%



The Dutch buildings in Haifa street	Evaluation the quality of the model according to the appropriate urban scene indicators	Evaluation the quality of the model according to the indicators of aesthetic relations in the urban scene	Evaluation the quality of the model according to the indicators of the aesthetic elements of noise barriers	Average rating for all indicators at each model
Model 1	71%	72%	71%	71%
Model 2	85%	85%	83%	84%
Model 3	64%	65%	65%	65%
Model 4	78%	77%	79%	78%
Model 5	68%	68%	68%	68%
The Korean buildings in Haifa street	Evaluation the quality of the model according to the appropriate urban scene indicators	Evaluation the quality of the model according to the indicators of aesthetic relations in the urban scene	Evaluation the quality of the model according to the indicators of the aesthetic elements of noise barriers	Average rating for all indicators at each model
Model 1	48%	54%	54%	52%
Model 2	60%	61%	60%	60%
Model 3	64%	64%	65%	65%
Model 4	49%	50%	50%	50%
Model 5	78%	79%	79%	79%
Al-Saydiyah residential complex	Evaluation the quality of the model according to the appropriate urban scene indicators	Evaluation the quality of the model according to the indicators of aesthetic relations in the urban scene	Evaluation the quality of the model according to the indicators of the aesthetic elements of noise barriers	Average rating for all indicators at each model
Model 1	78%	79%	76%	78%
Model 2	81%	81%	82%	81%
Model 3	69%	72%	74%	72%
Model 4	79%	79%	77%	78%
Model 5	62%	62%	62%	62%

## Conclusions

1. Noise barriers have a positive impact on the urban scene. Almost all of the tested models on the applied side achieved acceptance and achieved the three indicators, according to the opinion of the respondents, with rates exceeding (50%), with the exception of two models out of twenty-five proposed whose percentage was below the standard (this is according to the indicator Adequate urban scene indicators).
2. It is possible to determine the types and forms of noise barriers that are compatible with the elements of the urban scene suitable for the city by designing them according to: indicators of the urban scene assessment, indicators of aesthetic relations in the urban scene, and indicators of aesthetic relations of noise barriers.
3. The three main indicators converge to each other in terms of importance and the need to work according to their concepts, based on the convergence of results for the same model for each of these indicators.
4. Based on the results of the questionnaire, it was concluded that the best models of noise barriers are plant walls, and structures reinforced with plants (green walls). And they have achieved the highest percentages, according to the results.
5. The results of the questionnaire showed that the worst models, which achieved the lowest percentages according to the opinion of specialists, are the models of metal barriers.

## Recommendations

1. Commitment to the laws established regarding noise and noise pollution and their application to those who cause noise of all kinds, and not to be negligent in the matter because of its many damages.
2. Disseminating and following possible solutions to reduce noise pollution of residential complexes in particular and the rest of the noise-affected areas in general.
3. Setting laws that oblige designers to plan and design appropriately for buildings, residential complexes and other facilities to apply the necessary mechanisms to reduce noise pollution affecting the level of these facilities in terms of the building materials used and the design of building shapes, finishes and treatments that can be applied.
4. Setting and activating laws that oblige designers to plan and design appropriate barriers, and mechanisms that help them apply the theory of barriers in the city in a positive manner that fits and integrates with the indicators and relationships of the urban scene.
5. The concept of green plants when designing noise barriers should be one of the designer's options, or rather at the forefront, as the introduction of the green concept in the design of noise barriers is the best way to beautify the visual scene of the city, and to implement the urban greening policy on the other hand.
6. Commitment to the basic indicators to achieve the appropriate scene when planning the design of noise barriers in order to avoid any ugly formation in the surroundings and not to disrupt the image of the urban scene in general.

## References

- Abdul-Qadir, R. (1990) The Effect of the Formal Components of Urban Blocks on the Noise Level of the Residential District: Master's Thesis in Architecture Submitted to the University of Baghdad, College of Engineering: Baghdad - Iraq.
- Ahmed, H. (1989) Noise of External Sources in Residential Buildings: An analytical field study of the internal and external influences on the spaces of residential buildings, Master's Thesis in Architecture Submitted to the University of Baghdad - College of Engineering - Department of Architecture.
- Alam, P., Ahmad, K., Afsar, S. and Akhtar, N. (2020) 3D noise mapping for preselected locations of urban area with and without noise barriers: A case study of Delhi, India. *Noise Mapping*, Vol. 7 (Issue 1), pp. 74-83. DOI [10.1515/noise-2020-0006](https://doi.org/10.1515/noise-2020-0006)
- Al-Aqili, M. (2003) The Impact of the Jami Mosque on the Urban scene of the City, Doctoral Dissertation Submitted to the Higher Institute of Urban and Regional Planning at the University of Baghdad.
- Al-Bahrani, H. (2009) A Field Study on the Most Important Sources of Noise Pollution in the Residential Neighborhoods of the Cities of Najaf and Kufa, Research Published in *Al-Qadisiyah Journal of Engineering Sciences*, Vol.2, No.4.
- Al-Baluri, I. (1997) Contextuality in Architecture: Introducing New Urban Components in the Context of an Old Textile, University of Baghdad: Master's Thesis in Architecture.
- Alberts, W., O'Malley, V., Byrne, S., Faber, N., & Roebben, M. (2017) Technical report 2017-01. State of the art in managing road traffic noise: noise-reducing pavements. Conference of European Directors of Roads Avenue d'Auderghem 22–28 1040 Brussels, Belgium.
- Al-Mubarak, A. (1999) Coherence and Deconstruction in the Urban Scene Environment of the Contemporary City, University of Baghdad: Master's Thesis, Urban and Regional Planning Center.
- Al-Samarrai, Kh. (1987) The Impact of Traffic Noise on Some Residential Areas of the City of Baghdad, Master's Thesis Submitted to the Urban and Regional Planning Center for Graduate Studies at the University of Baghdad.

- Al-Samarrai, S. (2006) The Semantic and Emotional Meanings of the Urban Scene, Master's Thesis Submitted to the Department of Architecture at the University of Technology: Baghdad.
- Aminzadeh, B. (2010) Developing urban aesthetic criteria based on user preferences", 17th Conference International Seminar on Urban Form, 19-23 August, Hamburg: Germany.
- Attia, N. (1991) The Effect of the Formal Characteristics of the Spatial Organization within the Residential Neighborhood on the Level of Traffic Noise", Master's Thesis Submitted to the Department of Architecture at the University of Technology.
- Bane-Karash, I. (2015) Sound and Noise Control, Ministry of Higher Education and Scientific Research : Iraq, Northern Technical University.
- Bowker, G. E., Baldauf, R., Isakov, V., Khlystov, A., & Petersen, W. (2007) The effects of roadside structures on the transport and dispersion of ultrafine particles from highways. *Atmospheric Environment*, 41(37), 8128-8139. DOI: [10.1016/J.Atmosenv.2007.06.064](https://doi.org/10.1016/J.Atmosenv.2007.06.064)
- Broadbent, G., (1989) Emerging concepts in urban space design, London: Van Nostrand Reinhold (International).
- Cullen, G. (1961). *The Concise townscape*. Routledge/Architectural Press, London.
- Elias, I. (1989) The Foundations of Urban Renewal of the Heritage Fabric, the Effect of Organizing the Urban Scene on the Renewal of the Heritage Fabric, Unpublished Master's Thesis, Department of Architecture, University of Technology : Baghdad.
- Fleming, G. G., & Rickley, E. J. (1992) Parallel barrier effectiveness under free-flowing traffic conditions. United States. Federal Highway Administration.
- Hammoud, M. & Khudair, A. (2015) Visual Sustainability in Residential Spaces, a Survey of Outdoor Spaces in Selected Housing Complexes From Baghdad, Research Published in the *Journal of Planning and Development*, No.32.
- Hefta, R. (2014) Studying the Elements of the Architectural and Urban Scene, Master's Thesis in Architecture Submitted to Damascus University, Architectural Design Department.
- Hussein, H. (2017) The Impact of Advertising Signs on the Urban Scene of City Centers: Bab Al Sharqi & Sahat Altahrir: A Case Study, Master's Thesis Submitted to the Department of Architecture, University of Baghdad.
- Ibrahim, O. (2007) Visual Pollution and its Impact on the Contemporary Egyptian City, Al-Azhar Ninth International Conference Engineering, Al-Azhar Engineering Journal : Cairo.
- Ibrahim, S. (2010) The Impact of Pedestrian Roads Design in Providing a Comfortable Environment for Humans, *Journal of Society and Development*, Vol.15, No.22.
- Jean, P. (2000) The Effect of Structural Elasticity on the Efficiency of Noise Barriers, *J Sound Vib*. 2000;237(1):1–21. DOI: [10.1006/jsvi.2000.3059](https://doi.org/10.1006/jsvi.2000.3059)
- Jiang, L. and Kang, J. (2016) Combined acoustical and visual performance of noise barriers in mitigating the environmental impact of motorways. *Science of the Total Environment*, 543 (Part A). pp. 52-60. DOI: [10.1016/j.scitotenv.2015.11.010](https://doi.org/10.1016/j.scitotenv.2015.11.010)
- Kawthar, Kh., (2009) Visual Pollution and its Impact on the Urban Scene of the Iraqi City, Higher Institute of Urban and Regional Planning, University of Baghdad.
- Kotzen, B. & English, C. (2014) *Environmental noise barriers: a guide to their acoustic and visual design*. CRC Press.
- McCluskey, J. (1979) *Road Form and Townscape*", The Architectural press : London.
- Megeron, M. (1963) *Face of Metropolis*; Random House, New York, p.233.
- Mohammed, A. (2011) The Effect of Using the Theory of Barriers to Reduce the Level of Internal Noise of the Factory in Raising Performance Efficiency: A Case Study in Al-Furat State Company for Chemical Industries: Plastic Bags Factory, *Journal of Administration and Economics*: Vol.34, No.90.
- Mohammed, S. (2015) The Impact of Urban Street Design Principles on the Visual Perception of the Commercial Street, Doctoral Dissertation in Architecture.
- Musa, A. (2006) *Environmental Pollution*, Second Edition, Syria, Damascus: Dar Al-Fikr for Publishing and Distribution.

- Odeh, M. (2007) The Urban Scene of the City Center and Contemporary Trends : An Analytical Study of the Mahmudiyah City Center, Unpublished Master's Thesis Submitted to the Department of Architecture : University of Technology, Baghdad.
- Punter, J. & Carmona, M. (1997) The Design Dimension of Planning: Theory, Content and Best Practice for Design Policies. E & FN Spon, London.
- Rapoport, A. (1977). Human Aspects of Urban Form: Towards a Man-Environment Approach to Urban Form and Design, Urban and Regional Planning Series 15. Oxford: Pergamon Publishing.
- Rassam, M., (2004) The Effect of Addition and its Original Presence in the Urban Scene, Doctoral Dissertation, Department of Architecture, College of Engineering, University of Baghdad.
- Spreiregen, D. (1965) Urban Design : The Architecture of Towns and Cities, Mc Graw- Hill Book Company : New York, 1965.
- Thapa S., Ghimire A., Adhikari J., Thapa A. and Thapa B. (2020) Impacts of sowing and climatic conditions on wheat yield in Nepal. Malaysian Journal of Halal Research, Vol.3 (Issue 1), pp. 38-40. DOI [10.2478/mjhr-2020-0006](https://doi.org/10.2478/mjhr-2020-0006)
- Tucker, C., Ostwald, M., Chalup, S., & Marshall, J. (2005). A method for the visual analysis of the streetscape. In Space Syntax 5th International Symposium (pp. 519-529).
- Tugnutt, A., & Robertson, M. (1991). Making townscape: a contextual approach to building in an urban setting. London, Batsford.
- Ward, P. (1968) Conservation and Development in Historic Towns and cities, Oriel Press limited, London.
- Yeung, J. (2008). Application of Green Wall Panels In Noise Barriers. *Hong Kong*, 9.
- Young, G. (1977). Conservation scene: how buildings are protected - and why. Harmondsworth: Penguin Books Ltd, England, p.25.