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Chapter

Traffic Noise

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Abstract

Currently, noise pollution is a major problem especially in urban areas, and moreover traffic noise is the most significant source of noise in cities. A large number of cars and other road vehicles that have internal combustion engines are making road traffic noise a leading noise pollution source. Electric and hybrid cars, which are nowadays slowly replacing them, give rise to lower noise level in urban areas as their engines are generally silent. However, the mere absence of internal combustion engines cannot be the only measure for lowering noise levels in urban areas. The goal of this chapter is to define and describe traffic noise, the reasons for its occurrence, and all existing ways of reducing traffic noise.

Keywords: noise, noise pollution, traffic noise, electric and hybrid cars, noise reduction

1. Introduction

Nowadays noise pollution is the focus of various studies and research due to its proven significant impact on human health and work efficiency. Research shows that traffic noise in urban areas has tremendously increased since the beginning of the century, primarily due to increased transportation of people and goods. It can be concluded that in urban areas the largest source of noise is traffic-induced noise, which accounts for 80% of all communal noise sources. Traffic noise caused by road traffic is the most common type of noise in urban areas and as such poses a serious problem. **Figure 1** shows the distribution of human noise annoyance according to the type of noise source [1].

According to **Table 1**, provided by the International Union of Railways (UIC), all types of trains produce less noise than trucks, cars, airplanes, and other means of transport. Railway is the most favorable form of transport, in terms of noise as an influential factor for environmental degradation and human health. Therefore, it can be determined that the railway has the lowest share of noise in urban areas among other means of transport.

2. Traffic noise sources

2.1 Road traffic noise

Road traffic noise depends on the following three factors:

- Type of road vehicles.

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- Friction between the vehicle wheels and the road surface.
- Driving style and driver behavior.

When considering vehicles that have an internal combustion engine (ICE) as the noise source, most of the noise comes from the sources or systems shown in **Figure 2**. The aforementioned sources and systems are explained in detail in the following paragraph.

Engine noise is created during the process of compression and expansion in the engine, which creates engine vibrations which then emit noise. The engine noise depends on the engine volume, speed, and capacity. The suction system noise is caused by the opening and closing of the suction valves, and furthermore the intensity of such noise depends on the mode of operation of the engine, the speed of the engine itself, and the type of air filter. Noise from the exhaust system is created by the sudden release of gas into the exhaust system itself in order to open the exhaust valve. The fan noise is generated due to the operation of the fans in the vehicle, and the fans generally produce a broadband noise. Tire noise occurs when the tires and

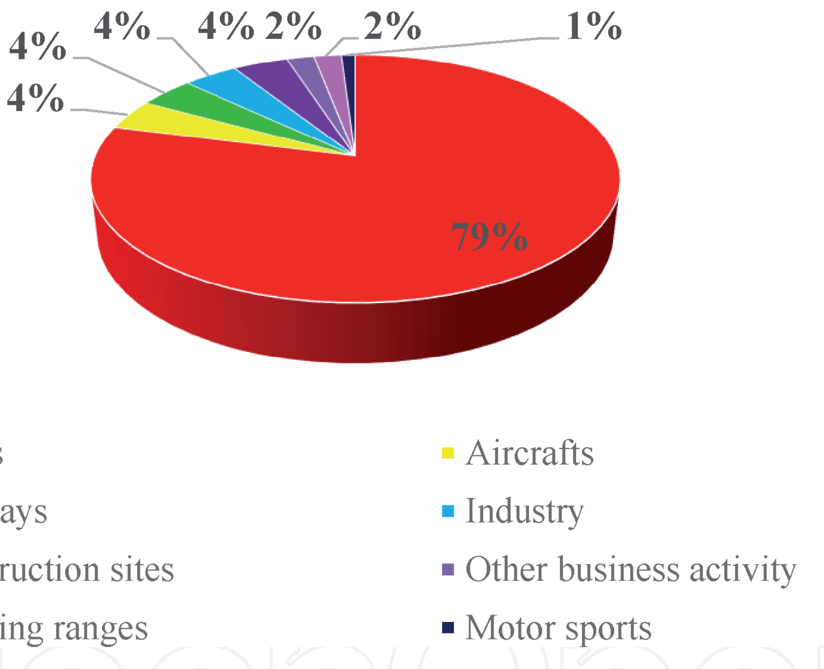

Figure 1.
Distribution of human noise annoyance according to the type of noise source [1].

Type of vehicle	Average noise level [dBA]
Car (700–1300 cm^3)	82
Motorcycle	90
Heavy cargo truck	103
Turbojet airplane	150
Fast passenger train	65
Cargo train (speed up to 120 km/h)	60
Local train	70

Table 1.
The average noise level generated by different types of vehicles (International Union of Railways (UIC)).

road surfaces come into contact. This type of noise depends on the type of road surface, the tire construction, and finally the speed and driving style [2].

In terms of noise pollution, electric vehicles represent the future, especially when compared to vehicles with an internal combustion engine (see **Figure 3**). However, at low speeds, electric vehicles produce very small levels of noise, i.e., in current acoustic urban environments, they are practically inaudible. For example, the noise level difference between an electric vehicle and an internal combustion

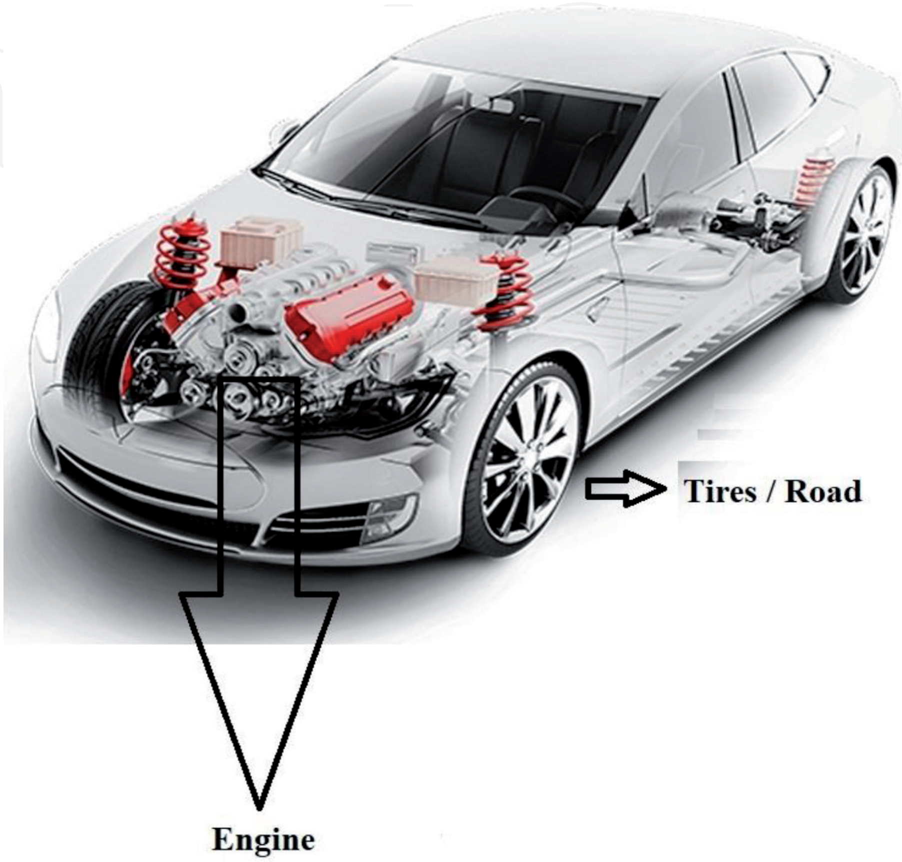

Figure 2.
Noise sources in a vehicle.

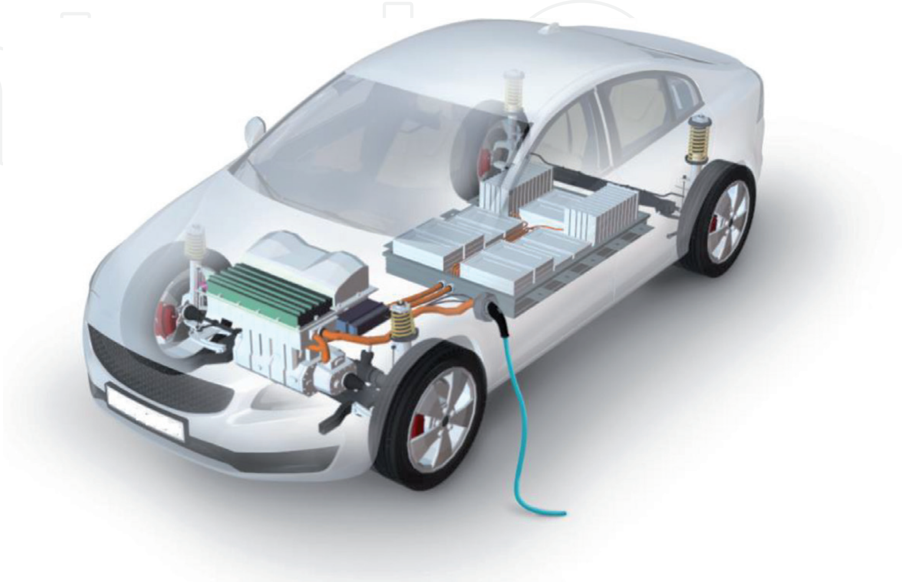

Figure 3.
Electric vehicle.

engine (ICE) vehicle can be greater than 6 dB (A) at 10 km/h. Unfortunately, much later at higher speeds, both types of car become equally loud, mainly due to tire noise.

When considering how traffic flow affects the subjective perception of noise levels, it can be concluded that it depends on the number of vehicles, their speed, and structure as described in the following paragraph.

A traffic flow of 2000 vehicles per hour produces twice the perceived noise level than 200 vehicles per hour. If the traffic speed is 105 km/h, it produces twice the perceived noise level than the 50 km/h traffic flow. One heavy weight vehicle (HV > 3.5 tons) with a speed of 70 km/h creates a perceived noise level of 28 light-weight vehicles (LV <3.5 tons).

2.2 Railway traffic noise

The main sources of railway traffic noise are noise generated from:

a. Vehicles traveling the railway.

b. Maneuvers.

c. Wagons.

d. Electromotor trains.

e. Motor trains.

f. Warning signals.

There are several other significant sources of noise, apart from the main sources mentioned above, which are:

- Propulsion systems for railway and railway vehicles.
- Interaction of wagon wheels, locomotives, and trains with rails.
- Braking process.
- Additional equipment such as ventilation, sirens, air-conditioning, and heating.
- Aerodynamic noise, especially in the case of high-speed trains.

On the propulsion system, noise is mainly generated by the operation of the traction engine (suction and exhaust process in the case of the diesel engine which is also the noisiest type of engine), the engine cooling system, the transmission system, and the ventilation system.

Wheel-rail interaction generates dominant noise in railway vehicles and depends directly on the speed of movement and the geometric configuration of the railway track. When moving on straight railway sections, the noise is mainly generated as a result of the roughness of the wheel and rail surfaces, i.e., from their friction. When driving through the railway curves, the wheels make more noise, not only due to rolling but also due to slipping of the metal wheels, which can be observed as creaking along the railway track. The cause of this phenomenon is the constructive

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nature of the wagons themselves, in which the wheels are fixed with parallel axles, which is why the outer wheels, when crossing a longer path than the inner ones, must glide, thus generating noise.

The noise generated by the braking process, in addition to the roughness of the wheels and track contact surfaces, depends significantly on the type and form of used brakes.

Noise from additional equipment is mostly generated by fans and their engines. Furthermore, it is important to mention the noise generated by the warning and notification signals.

Aerodynamic noise is caused by the passage of the train through the airspace. The noise level generated by air turbulence at or near the train surface in motion is logarithmically proportional to the train speed; therefore aerodynamic noise is significant only at higher speeds [3].

Figure 4 shows the noise sources of a high-speed train, apart from ground vibrations resulting from its passage and the conversion of structural sound to airborne sound in buildings.

2.3 Aircraft traffic noise

Aircraft traffic also causes several environmental problems or in other words an increase of noise. Nowadays, when observing the rapid development of all types of traffic, especially aircraft traffic, it can be concluded that there has been a significant increase in noise levels. In particular, the population living near airports is affected by the negative effects of noise exposure.

Aircraft noise can be divided into groups, which are shown in **Figure 5**:

- Noise caused by different types of engines.
- Noise caused by aircraft structure.

The noise sources generated by the engine groups are:

- Turbojet engine.
- Turbofan engine.
- Propeller propulsion (classic or turbine engine).

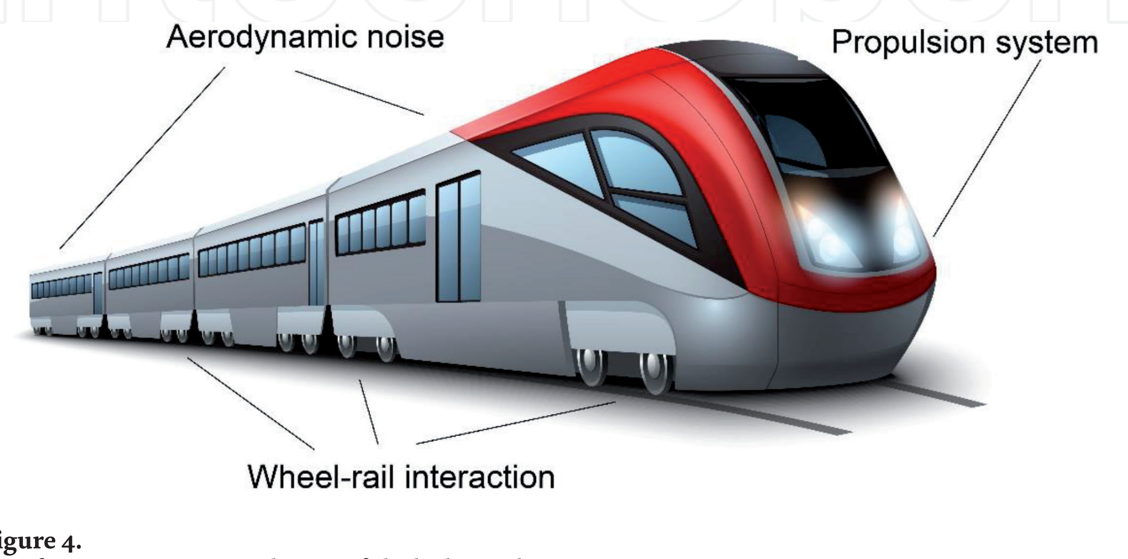

Figure 4.
Significant noise sources in the case of the high-speed train.

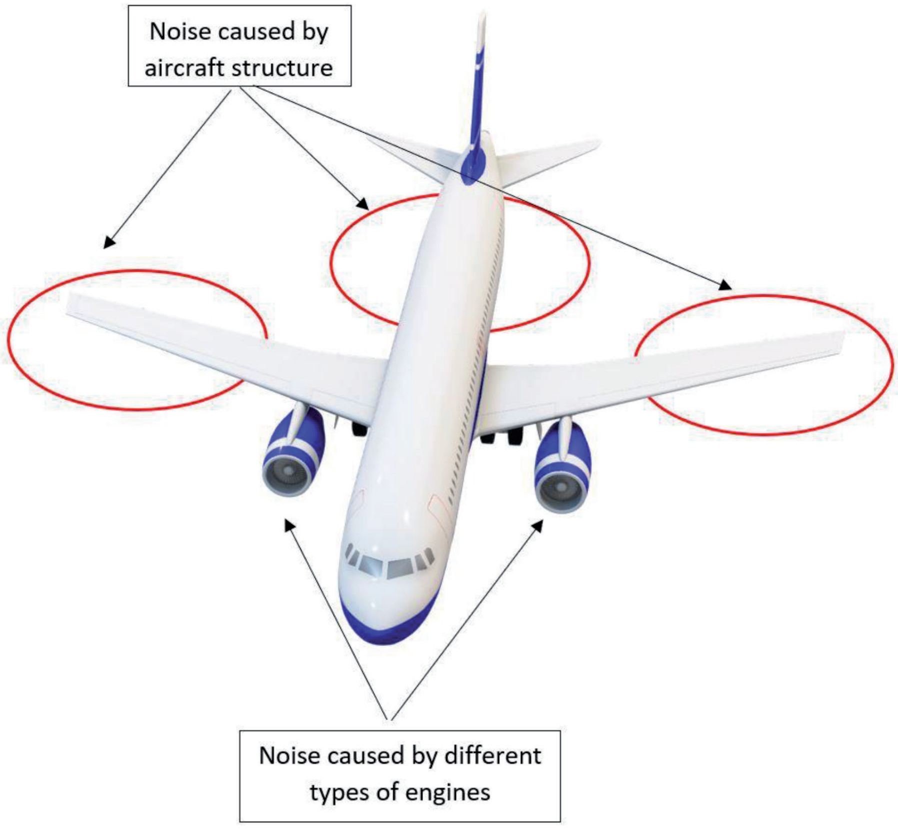

Figure 5.
Significant aircraft noise sources.

The noise produced by a turbojet engine can be divided into following groups:

- Compressor noise.
- Vibration-induced noise.
- Output jet noise.

Turbojet engine noise presented a big problem in the 1960s, especially the intake noise of this type of engine. The noise source of such intake noise is the compressor blades. During time as technology has evolved, aircrafts have become quieter, and therefore noise reduction in that sense continues even today.

The turbofan engine was designed to reduce aviation noise levels. In the case of the first turbofan engines, the largest noise source was the compressor, turbine, and jet exhaust. Newer turbofan engine models have succeeded to reduce the aforementioned noise levels. Turbofan engine consists of blades and a turbojet engine. This type of engine is often used in commercial aircraft industry.

Aircraft structure noise is defined as the sound which is produced from the movement of air between a solid body and air. The largest "manufacturers" of aircraft structure noise are landing gear, aircraft wings, and the flaps which are shown in **Figures 6** and 7. The noise generated by these aircraft parts depends on different aircraft configurations.

The noise level of an aircraft takeoff can be compared to the noise level produced by the engine group, while the landing aircraft engine group noise level is almost insignificant.

The noise produced by the flaps is created by the outer edges of the flaps. The main cause of flap noise is the emersion of air vortex which is created by flap extension. This vortex is the main cause of noise at the end of the wings.

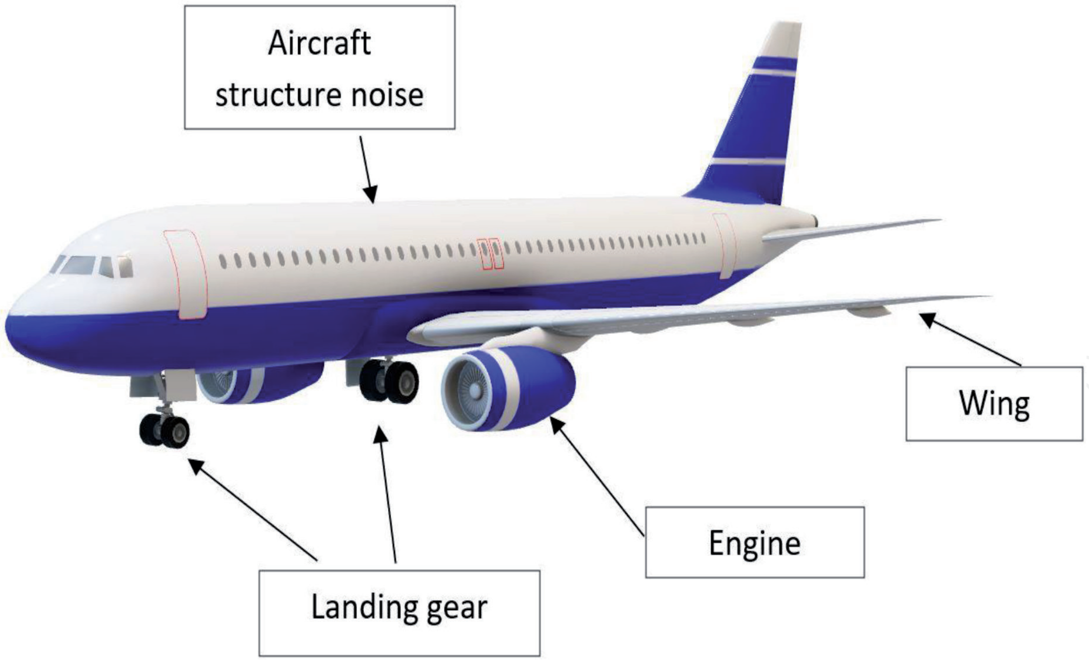

Figure 6.
Aircraft structure noise sources.

Figure 7.
Wing with extended flaps.

Another significant source of aircraft structural noise is landing gear. Landing gear noise is generated during takeoff and landing of an aircraft. During takeoff and landing, the landing gear is lowered; thus high air resistance occurs, which produces the landing gear noise [4].

2.4 Other types of noise sources

Other noise sources include industrial noise, noise caused by various construction work, and noise produced by different music and sports events.

Industrial noise (shown in **Figure 8**) is the amount of acoustic energy received by the human hearing system while working at the industrial hall. Occupational noise or industrial noise is a common term used when it comes to occupational

Figure 8.
An example of industrial site which produces industrial noise.

safety, since prolonged exposure to this type of noise can cause various health problems (e.g., annoyance, loss of concentration, sleep disorders, headaches, etc.). The worst consequence of prolonged exposure to this type of noise is permanent hearing impairment. Bearing in mind all the above, it can be concluded that this kind of noise certainly affects work efficiency.

When considering noise caused by different construction sites which are shown in **Figure 9**, this type of noise can have extremely high noise levels. Furthermore, such noise levels are very variable given that the construction process has many different phases. Thus, depending on the type and phase of construction, this category of noise can have indoor and outdoor noise sources and sometimes both at the same time. Activities on construction sites include the use of hammers, off-road trucks, cement mixers, cement cutters, electric saws, welding machines, as well as noise generated by hand tools such as a drill. Therefore, such noise represents a challenge for the workers and in addition for the population located near the construction site. This type of noise may have health consequences identical to those described in the previous section for the case of industrial noise.

Musical events are very dynamic (see **Figure 10**). In this case, the sound engineer plays a key role in ensuring that the audience gets the full experience of a music event by mixing the music. The order of the songs is usually strategically set in a way that higher levels of tempo or dynamics and energy remain until the end of the night, which represents a certain kind of "peak" of the concert. Naturally, the sound engineer will want to raise the sound levels as much as possible, so it can be

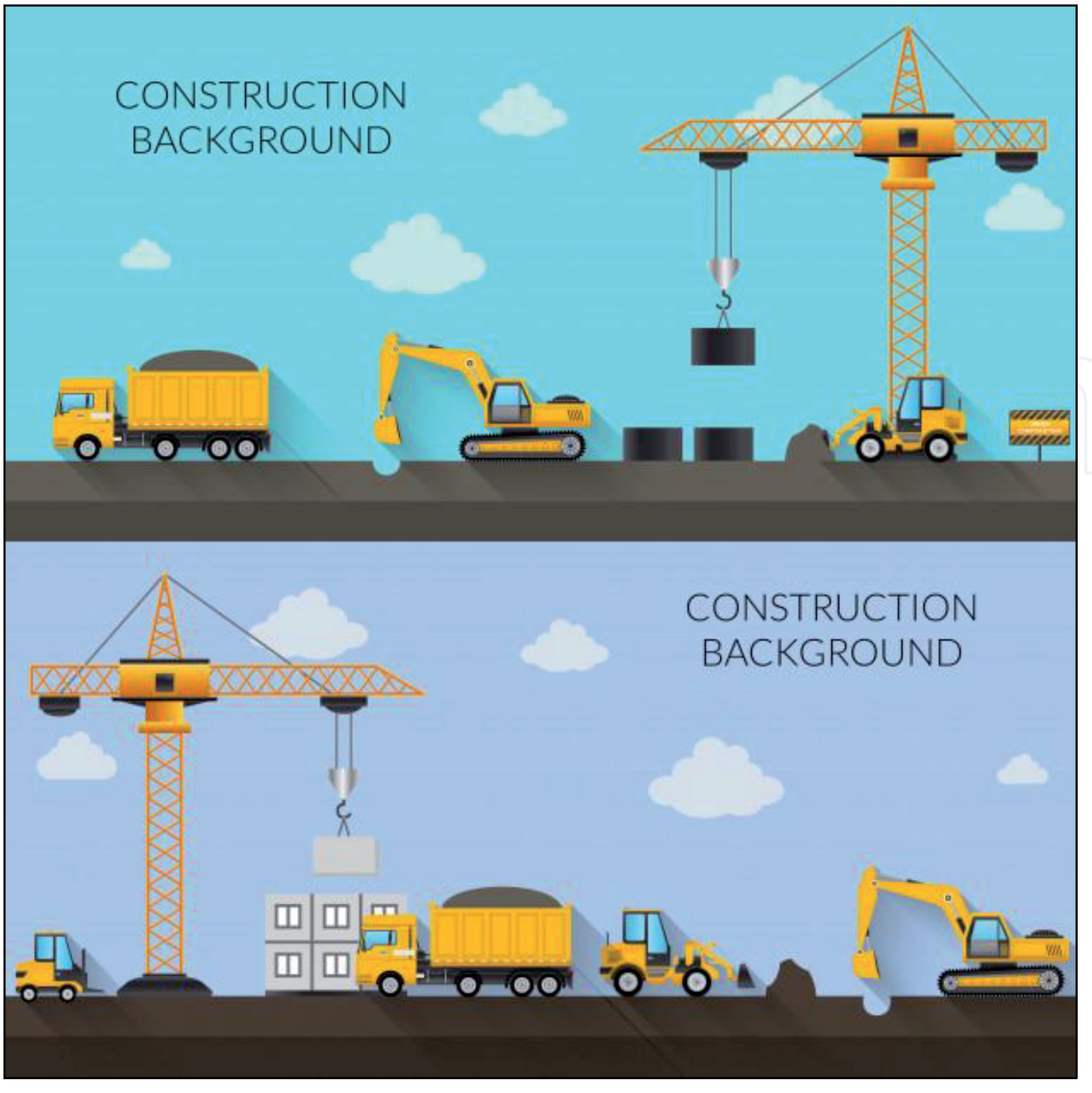

Figure 9.
An example of construction site and some typical noise sources.

expected that the noise levels will increase as the night passes. In addition, stage orientation plays a significant role in sound propagation. If the concert takes place outdoors, the reality is of course that people who are not actually present at the concert site, however live near, will hear the music. In that case it has to be noted that the music impact will be minimal at a distance of more than a mile or two from the concert site, so this type of noise could be annoying or unpleasant (especially if one does not prefer the music performed by an artist). The concert will certainly not be suspended due to a complaint from only one person living relatively near the concert site. Licensing of open-air concerts by the competent authority is a well-established process. Therefore, one can expect only a few concerts a year from a particular outdoor site. Concert organizers can in addition send notices to home-owners near the concert site reminding them of concert details, curfew time, and their right to complain if noise levels become significant and therefore annoying.

Sport events (shown in **Figure 11**) present a very similar situation as music events. Although most people enjoy them, those who are disturbed by the noise levels produced can be protected in some way by using different types of ear protection (e.g., noise-cancelling headphones or popularly called earbuds). For people who are particularly sensitive to noise, there still remains the option of simply physically moving away for a while from the site where a particular sporting or musical event will take place.

Figure 10.
An example of open-air musical event.

Figure 11.
An example of sport event.

3. Ten ways how to reduce noise levels

The previous sections of this chapter have described the most common traffic sources in urban areas. The aim of this paragraph is to propose and describe measures to reduce such noise which are shown in **Figure 12** [5].

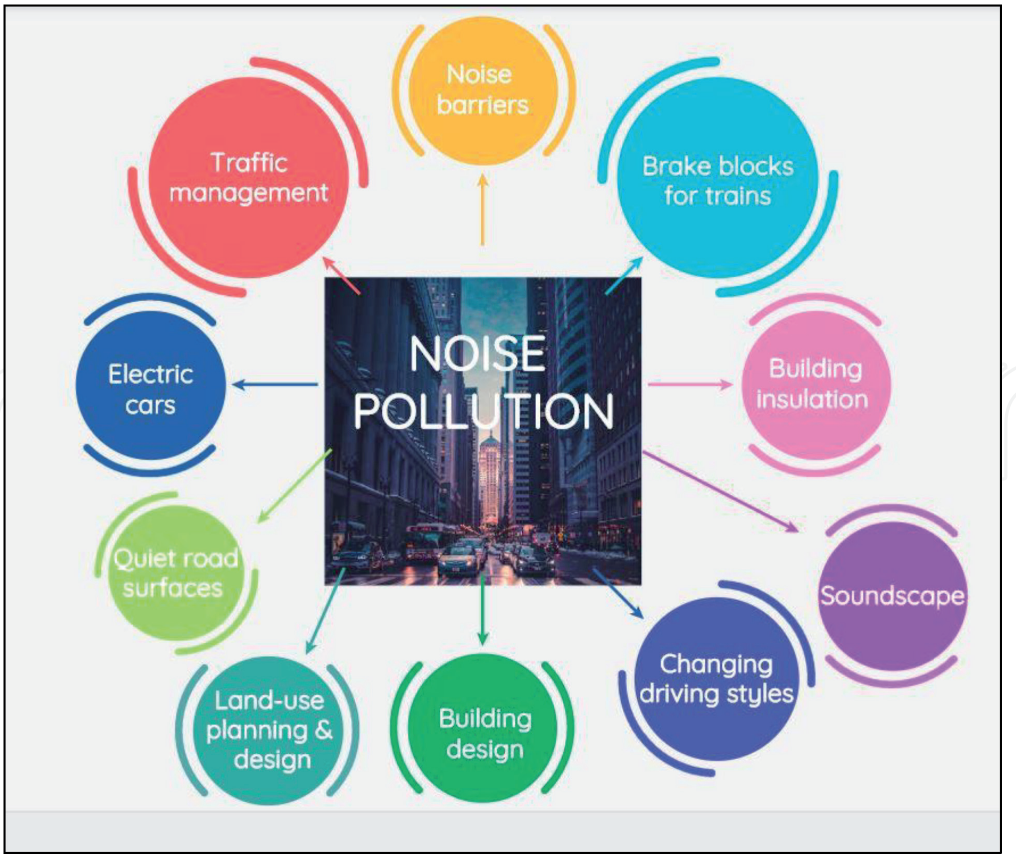

Figure 12.
Ten ways to reduce noise pollution based on [5].

Ten ways to reduce noise in urban areas proposed in [5] are:

- Urban planning.
- Designing living spaces.
- Sound insulation of living spaces.
- Smart traffic management.
- Implementation of quiet road surfaces.
- Development of train brake blocks.
- Electric cars.
- Changing driving styles.
- Noise barriers.
- Application of soundscape concept.

It is important to emphasize that these solutions are not the only solutions and that there are still different opportunities and prospects for progress and development of both existing and new methods.

In the following sections, a more detailed explanation on how electric vehicles affect the reduction of noise levels will be provided, especially in urban areas. On the other hand, problems which occur with electric cars will be discussed. In addition, the effect of smart traffic management system, traffic behavior changes, and quiet road surfaces in terms of noise reduction will be examined.

3.1 Electric vehicles

Electric vehicles (shown in **Figure 13**) present the future in terms of reducing noise pollution in urban areas. Electric vehicles are quieter especially when compared to vehicles with an internal combustion engine.

Electric vehicles at low speeds produce very low levels of noise, i.e., in current urban environments, these vehicles are practically silent and unnoticeable. For example, the difference in noise level between an electric vehicle and an internal combustion engine vehicle can be greater than 6 dBA at 10 km/h [6]. At higher speeds, both types of vehicles become equally loud, mainly due to the tire noise. In urban areas, for pedestrians (especially for vulnerable groups: children and visually impaired people), it becomes much more difficult to detect electric vehicles due to their aforementioned lower noise levels [6]. Therefore, it is necessary to find a solution in the form of an audible signal that electric vehicles will emit in different driving modes.

Since 2009, the Japanese government, the United States Congress, and the European Commission have been studying the legislation to determine the minimum level of emitted sound signal for plug-in electric and hybrid vehicles when operating in electric mode. This level of audible signal must be such that visually impaired people, other pedestrians, and cyclists can hear the electric vehicles in motion and detect from which direction they are coming from. Several tests and studies have shown that vehicles operating in electric mode below 32 km/h are almost inaudible for pedestrians [7].

In 2011, the European Commission composed guidelines for Acoustic Vehicle Alerting Systems (AVAS). The aim of the guidelines was to present

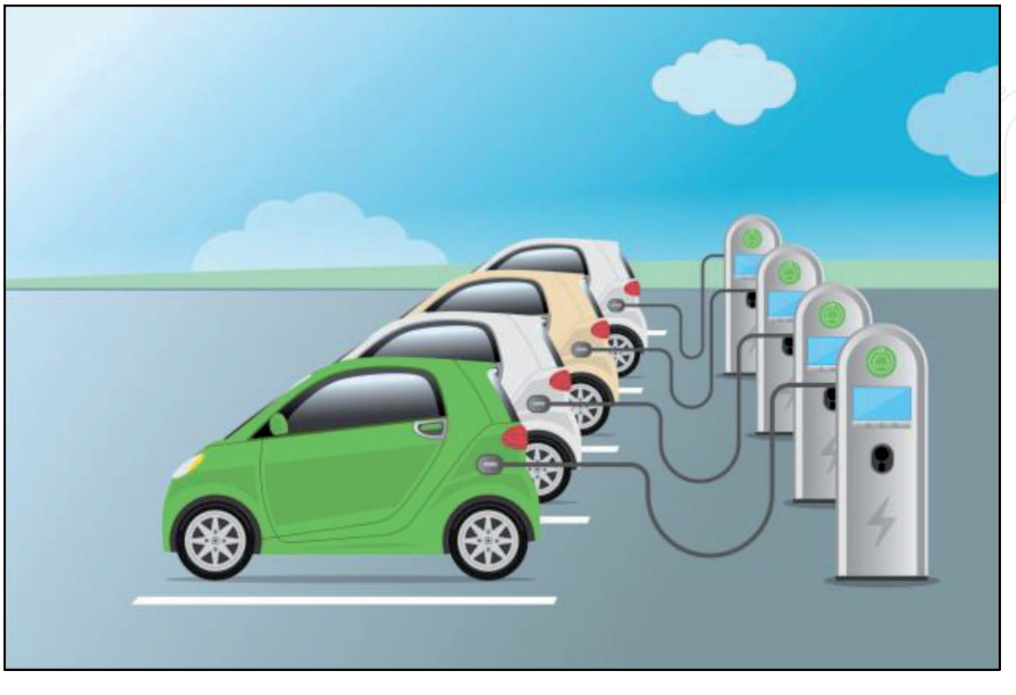

Figure 13.
Electric vehicles: the future.

recommendations to manufacturers for a system to be installed in this type of vehicles that would emit an audible signal to pedestrians and other vulnerable groups in traffic. The guidelines recommend that AVAS automatically generate a continuous sound in the minimum range of vehicle speeds from standing at a place (0 km/h) and starting to drive (up to approximately 20 km/h) and when driving backwards, if applicable to that category of vehicle. Furthermore, the guidelines suggest which types of sounds are not suitable for this purpose [8]. In February 2013, the European Parliament decided that the law draft should combine series of tests, norms, and measures that first must be developed in order to make AVAS mandatory in the future. The approved amendment stipulates that "the sound generated by the AVAS should be a continuous sound of the vehicle in operation providing information to pedestrians and vulnerable traffic users. The sound should clearly demonstrate the behavior of the vehicle and should sound similar to the sound of a vehicle of the same category equipped with an internal combustion engine" [9]. In April 2014, a law (Regulation (EU) No 540/2014) was approved by the European Parliament requiring AVAS to be mandatory for all new electric and hybrid vehicles. The new guidance proposes a transitional period of 5 years after the announcement of the final approval of the April 2014 proposal [10].

For example, a case study was carried out in Zagreb in 2019 [11], which involved 201 participants who had the task to fulfill a specially designed questionnaire. This case study addresses the issue of electric cars in everyday traffic. The research was focused on assigning a desirable (both for pedestrians and drivers) and, at the same time, detectable warning sound to an electrical vehicle in the daily traffic. The case study showed that the majority of participants (especially the ones with a driving license) would prefer that their electric vehicle sounds like an internal combustion engine car. The "nondrivers" were more open to the solution that an electric vehicle has a different sound than a "regular" car. According to the study, they were more opened to a solution of adding a sound of an electric motor to the electric vehicle as a warning sound which would distinguish the electric cars from cars with internal combustion engine in everyday traffic. However, an important question concerning the overall quality of life remains: "Which one of these two sounds would increase more the noise levels in urban environments?"

Finally, it can be concluded that electric vehicles will play a significant role in reducing noise levels especially in urban areas while adequately addressing the problem of emitting a certain warning sound when parking, moving forward, and stopping. It is important to note that the unique warning sound has not yet been implemented, i.e., various car manufacturers are still "experimenting" regarding this issue.

3.2 Smart traffic management

Smart traffic management is a system in which centrally controlled traffic signals and sensors regulate the flow of traffic through the city in compliance with the current state on the roads in the city (see **Figure 14**).

Upgrading and integrating all the signals on major roads in the city will have multiple benefits such as:

- Significant reduction of daily traffic congestion, equalization of traffic flows, and prioritization of traffic in response to real-time demand.
- Pollution reduction in the city: stop-start driving is inefficient and polluting.
- Providing priority for busses approaching intersections and phase-coordinating traffic lights enabling a "green wave" through the city.

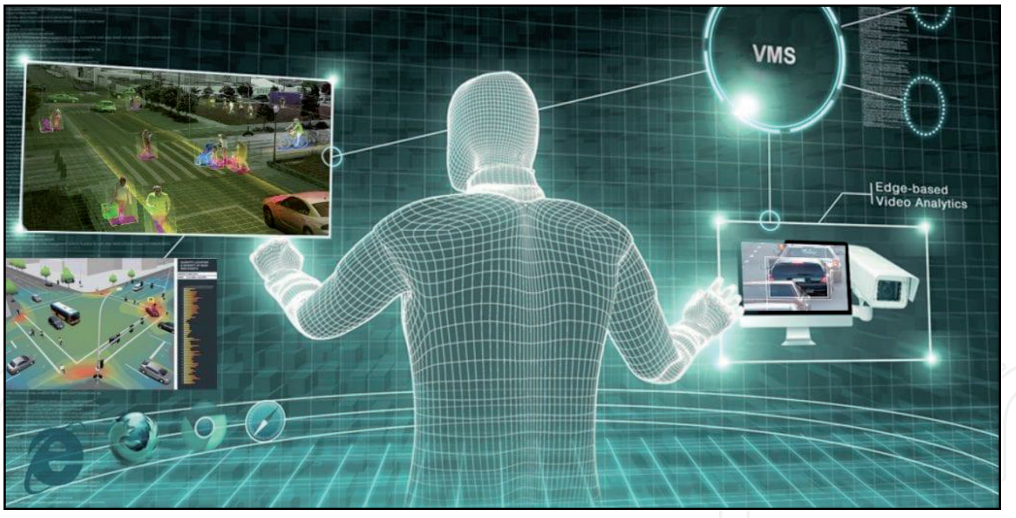

Figure 14.
Smart traffic management system.

- Enabling a much more efficient response to traffic accidents, especially on motorways, for example, the system can be pre-programmed for a sudden increase in traffic.

- Enabling inbound traffic flow control.

In addition to the multiple benefits listed above, the system would also provide the perfect opportunity to install tracking equipment and collect a much more detailed traffic and travel data. Each set of traffic lights would have communication equipment that can be used to transmit (anonymously) vehicle data, either from automatic number-plate recognition (ANPR) cameras or Bluetooth detectors and closed-circuit television (CCTV) transmission (if suitable). There are three components in smart traffic management: traffic lights, queue detectors (in terms of traffic congestion) embedded in the road, and cameras and a central control system. Queue detectors define the traffic flow control system on all major roads in the city. The system controls the traffic lights to maintain the free flow of traffic within the city. Every 2 seconds, the system uses a real condition model to decide whether one will have the priority of changing the phase of any of the traffic lights. A system software considered as an "asset" can be defined as, for example, obeying the bus timetable, less pollution at a particular location, or fewer vehicles waiting at a highway toll booth.

If inbound traffic flow control is used, the most remote sets of traffic lights on arterial or radial roads serve as a special function and are technically known as "doors" or "control points." They regulate the flow of vehicles entering the city.

One example of software with the purpose of smart traffic management is split cycle and offset optimization technique (SCOOT) which is used in hundreds of European cities for decades. It is used in Cambridge for coordinating traffic signals, where it usually favors busses. In Zurich, Braunschweig, and Potsdam, the system is used to control all traffic in the city [12]. The software is deployed with "knowledge" of the road network and is trained to respond appropriately to a wide range of scenarios (e.g., major traffic "disruptions" such as an accident on the arterial roads). It is important to note that the system also has the option to manually manage and make changes if there is a need for it.

3.3 Changing driving styles

Traffic behavior psychology is defined as the study of the behavior and psychological processes of different traffic participants. Its aim is to attempt to identify specific behavior patterns of users of different types of traffic with the ultimate goal of developing effective anti-accident measures [13]. There are two basic approaches that can help psychologists develop and implement measures against traffic accidents. First, traffic psychology can act as an "assistant" of science with a dominant field of traffic engineering. Road safety engineering solutions aim to optimize internal road safety. A safe road can be defined as a road that is designed, operated, or modified in such a way that it [14]:

- Warns the driver of any unusual or odd features.
- Informs the driver of road conditions.
- Guides the driver through atypical parts.
- Controls the passage of drivers through problematic points and roads ("black" traffic points).
- Has the ability to tolerate a driver's impolite or inappropriate behavior.

Engineering is powerful for a significant number of traffic problems. However, it would be wrong to assume that it is exclusively an engineering solution. Engineering must also consider sociopsychological solutions that include the implementation, education, and other activities in order to change the behavior of road users. In a significant number of traffic situations, psychological measures can support engineering measures in such a way that the performance of expected safety works even more effectively by informing or motivating traffic participants to change their behavior in the desired direction.

Regarding the specific application of this topic to the issue of noise, changes in the traffic participants' behavior would mean a complete "openness" to newly developed traffic monitoring systems, participation in them, and raising awareness of the most vulnerable groups in traffic (visually impaired people and children). **Figure 15** shows worrying data which is a direct consequence of the current behavior of road users.

3.4 Quiet road surfaces

In previous paragraphs, it has already been established that the dominant noise source when driving a car at higher speeds is tire noise which is caused by friction between the wheels and the road surface. In the case of light vehicles, tire noise becomes the main noise source already at a speed of 30 km/h, while in the case of heavy vehicles at speeds higher than 60 km/h tire noise becomes the main noise source, which is shown in **Figure 16** [16]. **Figure 17** shows noise levels for different types of vehicles depending on their speed [17].

Tire noise depends on the following road surface properties:

- Surface texture.
- Acoustic absorption.
- Aerodynamic processes.

Improving road surface properties in a way that effectively reduces noise generation and amplification will result in lower noise levels. There are several types of quiet road surfaces, and their application is mainly determined by the noise

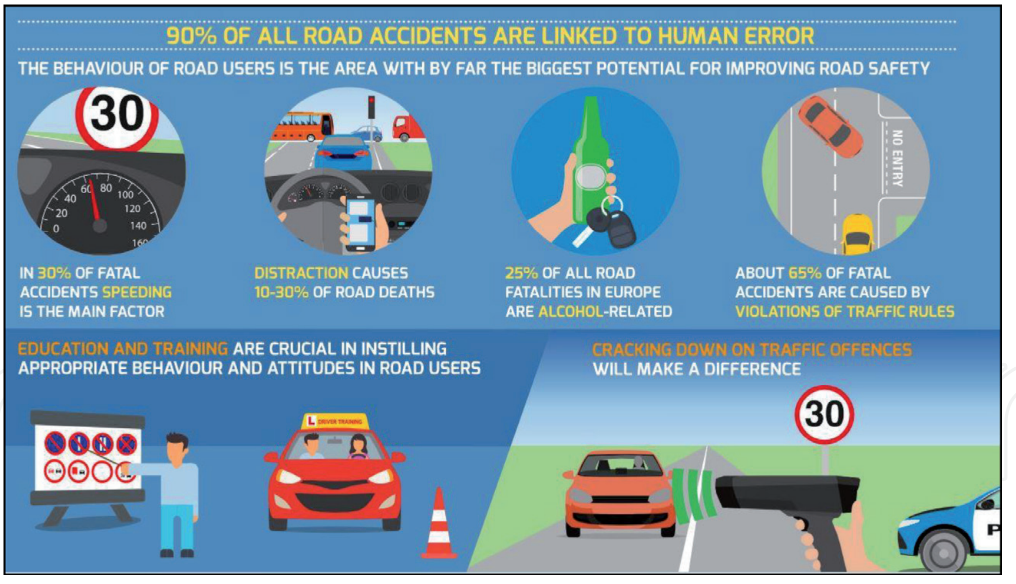

Figure 15.
Review of irresponsible and inappropriate traffic participants' behavior [15].

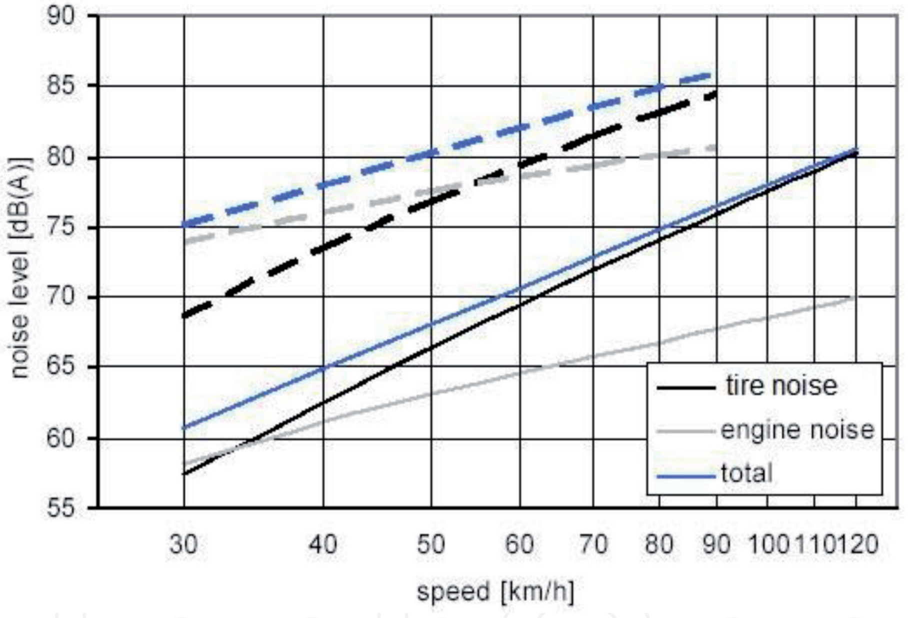

Figure 16.
The correlation of noise levels and vehicle's speed (lightweight vehicles marked with full lines and heavy weight vehicles with dashed lines) [16].

reduction proportion, the permitted speed in traffic, the composition of the traffic flow, and the possible adhesion of tires to the surface during parking. In urban areas, three types of bases are most commonly used:

- Thin surface layers.
- Two-layer porous asphalt.
- Cast asphalt.

Thin surface layers are often referred as thin asphalt layers of or thin asphalt bases for noise level reduction (see **Figure 18**) [1]. These layers are usually up to 3 centimeters thick. There are a significant number of different types of thin surface

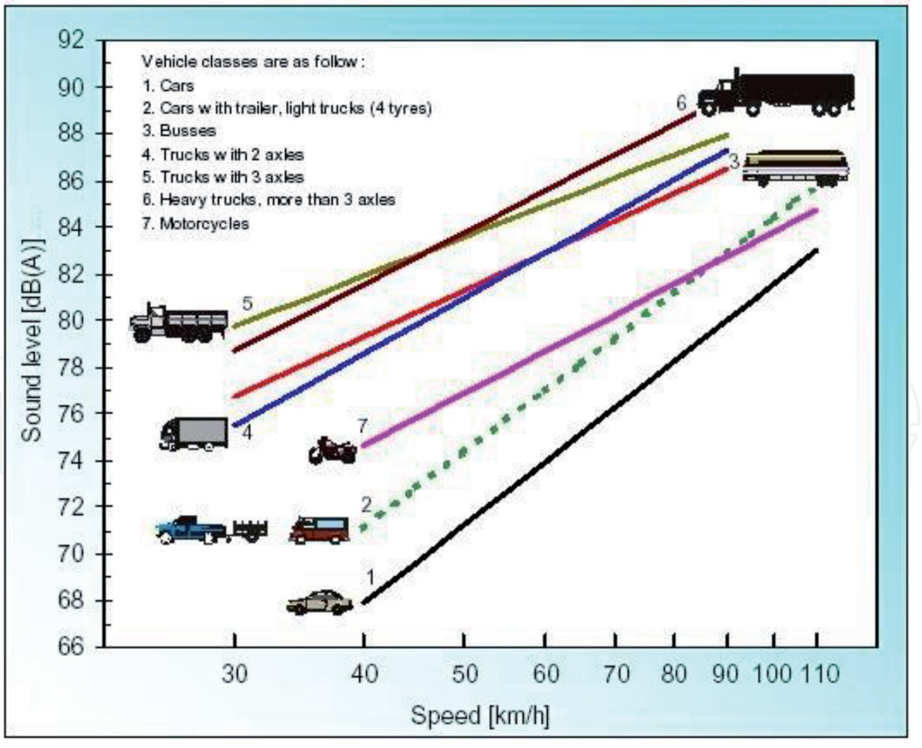

Figure 17.
Noise levels for different types of vehicles, depending on their speed [17].

Figure 18.
Two-layer porous asphalt (on the left) and a thin surface layer of asphalt (on the right) [1].

layers on the market, for example, in the Netherlands more than 40, including porous and dense types. They usually reduce noise by 2–4 decibels at 50 km/h for cars when compared to the average dense asphalt concrete. Porous asphalt types are in average about 1 decibel quieter than dense ones; however they have a shorter duration than dense asphalt. The typical duration of a thin surface layer is 7–9 years. Thin surface layers are suitable and increasingly popular on low- and medium-speed roads; however they are not appropriate for places exposed to strong stress forces, such as roundabouts, steep slopes, bends, truck exits, etc.

The two-layer porous asphalt consists of a top layer (2.5 centimeters thick) and a lower layer (4.5 centimeters thick) which is shown in **Figure 18**. The total thickness of the 7 centimeter porous layer absorbs more noise or more precisely at the beginning of its implementation from 5 to 7 decibels. Two-layer porous asphalt is relatively expensive and suitable for high-speed roads that require extreme noise reduction. Cast asphalt has a thin (3 centimeters) surface layer with a specific molding design. It contains more stone than thin surface layers, and since it is not porous, it does not absorb as much noise; however it is more robust than other

Tire size [inches]	Sound pressure level [dB(A)]
<145	72
145–165	73
165–185	74
185–215	75
>215	76

Table 2.
Table of decibels [18].

asphalts. A test of this type of cast asphalt conducted in Berlin resulted in an initial noise reduction of 1.5 decibels. In addition to installing quiet road surfaces, another method of reducing tire noise is the production of quiet car tires. There are several manufacturers that have developed such tires and successfully placed them on the market. In general, the comfort concept of tires is directly related to their loudness. One of the tire functions is to absorb impacts and dampen vibrations, which means that the tire is an element of the vehicle that ensures the travel comfort. Smaller wheels produce less noise. Basically, a smaller tire represents a smaller surface that adheres to the road and thus produces less noise. In addition to the size, the material from which the tire is made is also significant. There are softer types of rubber that also make less noise. Of course, one of the most important factors is the speed of driving. If one plans to drive at higher speeds, it makes sense to have tires with such performance. However, such tires are thicker and larger, thus creating more noise. Furthermore, weather conditions also play a key role in choosing tires. Tires selected for severe weather will create more noise due to certain safety aspects, i.e., the need to better adhere to the road surface. Tires selected for extreme weather conditions will make the highest noise level. According to their design, tires selected for city driving can make less noise. All of this logically implies that winter tires will make more noise than do summer tires.

Tire manufacturers can produce tires that make less noise. There are already various models, especially the quietest summer tires, which are 4–6 dB(A) below the limit, and many of the newer winter models are also approaching the limit of 2 dB(A). These restrictions are determined by Regulation No. 117 United Nations Economic Commission for Europe (UNECE)—Uniform requirements concerning the approval of tires regarding the emission of rolling sound and/or traction on rainy surfaces. The sound pressure levels generated by each tire size are shown in **Table 2** (for reinforced tires (XL), the limits are higher by 1 dB(A)) [18].

It can be concluded that noise can be limited by using modern quiet road surfaces which reduce its level from 3 to a maximum of 7 decibels. Unfortunately, such materials are usually 2.5 times more expensive than ordinary materials. Furthermore, noise can be reduced by using quieter tires by an additional 3–4 decibels; however the choice of tires depends on the preferences and habits of the driver. In the majority of cases, noise is reduced by speed limits on local roads and highways located near resident areas, and these restrictions are often even more restraining at night.

4. Conclusions

Noise pollution is a serious problem that affects the overall quality of life. This problem is especially noticeable in urban areas where a significant amount of

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noise pollution is produced by traffic. In this chapter the main traffic sources are described and analyzed. In addition to road, railway, and aircraft noise sources, other typical noise sources common for urban areas are also discussed. Bearing in mind the serious consequences of long-term exposure to noise, it is necessary to implement at least some measure to reduce noise levels. Today there are many initiatives and plans how to tackle this issue; however this chapter has focused on measures directly connected to traffic noise levels. In that sense, this type of noise reduction measures has been described and discussed in detail.

Furthermore, it can be concluded that education and some form of encouragement are needed to get the people more involved in the "fight" against noise and its negative impact. In this way, a kind of pressure would be created to set up the necessary city infrastructure (sensor networks), and finally the citizens would obtain a much-needed improvement of the quality of life in the environments in which they live.

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