Investigating the Effect of Traffic Flow on Pollution, Noise for Urban Road Network

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Abstract
Congestion has a significant impact on the environment. It's the predominant source of pollution, as noise and air pollution. The sound produced by vehicles as well as horns creates the worst possible environment. High motorized traffic flow nowadays is the major contributor to rising externalities, vehicle emissions, and other pollutants that impact the environment and the atmosphere, which result in negative atmospheric phenomena, global warming, and climate change. Vehicle emissions cause numerous vulnerabilities, so a serious consequence may arise in the long term, both regional and global. This study investigated Noise and pollution for different roads in the different cities based on field data at peak periods of traffic flow, shows that the major pollutants that are emitted from engines are: nitrogen oxides (NOX), carbon monoxide (CO), unburned hydrocarbons (CₓHᵧ), sulfur oxides (SOX), solid particles, including aerosols, as well as carbon dioxide (CO2).

Keywords: Emissions, traffic characteristics, urban mobility, sustainable indicators.

1. Introduction
Transportation activities, particularly in urban areas, continue to be a significant source of air and noise pollution. According to new World Health Organization data, nine out of ten individuals globally breathe air that exceeds WHO air quality guidelines.[1]. Motorized transport plays an important role in level and form of urban development, providing ways to serve more complex mobility needs, initially through public transport and lately through the rapid expansion of private car use. The shift made towards motorized mobility during the last decades becomes obvious by observing the temporal change of the private car ownership index. The problems arising in urban areas vary and have serious impacts on the natural and built environment and the overall life in cities. Extended use of transport can have effects on the environment and also on people who suffer daily from congestion, traffic noise, and increased pollutant and greenhouse gas emissions.[2]. Air pollution is a grave problem, as it increases not only environmental, but also economic and health risks Ambient air pollution is not just a global, but also a local issue[3].
Fuel combustion (e.g., gasoline, LPG, and diesel) produces various substances and gases in vehicle engines. The majority of them are carbon monoxide (CO), CO2, oxides of nitrogen (NOx), particulate matter (PM), and black carbon (BC) [5]. Through photochemical reactions, other harmful pollutants, such as ozone (O3), can be formed as a result of NOx emissions, acid rain, and photochemical smog (when volatile organic and nitrogen oxides are compounds they produced something called photochemical smog). Furthermore, they can react with any other substances in the environment to produce minuscule particles that may be dangerous to beings. Nitrogen dioxide (NO2) was noticed to have a linear correlation with cancer cases. A lot of environment regulatory authorities around the world have established NO2 limits in the air. For this purpose, safety limits are generally formed: one is for a long term, averaged over one-year exposure, also the other for short term, averaged over one-hour exposure, furthermore for noise pollution. Many factors that contribute to increased road traffic noise, particularly on highways, include noise that generated by the engine of a vehicles, exhausts, "tires-road" contacts, also the interactions between running vehicles and flowing air that passes through the car body, the conditions of road and managements of traffic, car speed, and traffic compositions [6]. US Agency of Environmental Protection established a safety limit of 53 parts per billion (ppb) over a year averaged and 100 parts per billion (ppb) over one hour averaged [7].

2. Transportation networks

The urban road transportation network is essential to regional development and is an effective force in shaping the city's spatial structure [8]. The road transportation network, in essence, serves as the backbone of human settlements. [9]. As a result, it plays a crucial role in defining the urban mobility pattern. [10]. To date, most network studies have been represented as two elements: nodes and edges.

3. Sustainable transportation

Green transportation refers to environmentally friendly modes of transportation. It is a term used to describe any transportation mode that has a low impact on the environment, like "non-motorized" transportation, "walking", "cycling", "transit-oriented development", "green vehicles", and "car-sharing". Sustainable transportation systems development or preservation in urbanized areas can result in more "fuel-efficient" transportations, conserving spaces, and promotion of healthy lifestyles. Sustainable transportation makes use of green or renewable resources, as well as nonrenewable resources produced at lower rates than renewables energy, whereas minimizing noise pollutions and exploitative land uses impacts [11]. congestions incur several economic consequences, such as squandering people's time and causing a delay in the arrival of services and goods. The real function of the transport system is to provide links to works,
educations, and goods or services. Strategies of conventional transport aim to improve movements, especially for cars, yet fail to account for transportation's broader impact. In contrast, novel transportation approaches aim for improving accessibility, at the same time the impacts are reduced in both environmental and social while managing traffic congestion. [12] Developments of transport infrastructures are based on principles that reducing operating costs while emphasizing the mobility of traffic and taking into account Considerations for people and the environment. currently, Global fears for climatic changes, the effects on the environment, and the strictly limited resources of the financial side highlight the need for new approaches in transport solutions selections. Consequently, in the transportation infrastructure system, There is an escalating desire to ensure the sustainability of the environment. A sustainable transport system should be healthy, more safe, accessible, and renewable, working fairly and limiting polluting gas emissions and the use of nonrenewable resources [13]. Transportation can be considered sustainable due to the impact it has on the environment and society. It can also be used to aid in the achievement of sustainability in other areas of human endeavor. Transportation can achieve this to reach sustainability [14]:

A. For society
  • in a way that doesn't put the social fabric under stress the transportation should fulfil human needs for convenience, health, and comfort.
  • provide and support human development, as well as a reasonable range of transportation modes.
  • Produce noise that not exceed the acceptable limits of communities.
  • provide safety for people and their property.

B. for economy
  • providing services and capacities that are cost-effective
  • In each generation, be financially accessible
  • Encourage a thriving, long-term economy.

C. for environment
  • for integrity of ecosystems the transportation should make use of land with no impacts on this system.
  • Using the sources of energy that aren't inherently renewable or inexhaustible sparingly.
  • Emit less waste and emissions that can be accommodated by the ability of the planet to restorative.

3.1. Sustainable Transportation Indicators

Indicators of sustainability is a method to estimate how often the existing system meets needs now and in the future, and how dependable and resourceful it is. [15] Indicators of sustainability are a significant tool for better transportation planning and operation. Some of these indicators are sustainable in all situations while others are sustainable in specific conditions [16], developing appropriate indicators for measuring the level of sustainability is the more challenging issue for sustainability and at the same time it's the common goal of sustainable transport. A lot of studies established technical or general indicators; some of the indicators are proposed for leading to dependable and adaptable implementation issues. the classification of the indicators is based on their impacts on the transportation system [17]. it's essential to measure the transportation impacts on the environment, economic and social, to ensure the reliability of the indicator to assess sustainability. Even though indicators can serve different purposes in different domains of use, they should be dependable in measuring the description level, impact prediction, simplification, and practicability in the framework of evaluating sustainable transport. In developing those indicators, All aspects of transportation activities' for the current and future impacts must be taken into account. Furthermore, clear and comprehensive indicators must be established in order to develop an assessment method for evaluating sustainable transportation as a whole system. Some indicators are:

- PM10 emissions from road Transport - CO2 emissions - N2O emissions - Average commute travel time - Mode split: a percentage of travels that made by - walking, cycling, ridesharing, and public transportation.
- commercial transportation profitability and speed - consumption of fossil fuels Per capita - and other
climate change emissions - percentage of a population who is subjected to extreme levels of transportation noise- land devoted to transportation facilities Per capita [18].

4. AIR AND NOISE POLLUTION ASPECTS

4.1. AIR POLLUTION

4.1.1. TRAFFIC FLOW EMISSIONS

Transportation activities are responsible for one-third of the chlorofluorocarbons (CFCs), one-fifth of the carbon dioxide (CO2), and the half part of nitrogen oxides (NOx) in the atmosphere. Transportation has serious environmental, social, and economic consequences, and thus it’s a vital aspect of sustainability [19]. The amount of gases released is related to the vehicle's velocity, the acceleration, and the level of performance “performance index for passenger cars and trucks” [20]. For private passenger vehicles, petroleum remains the most widely used fuel. Pollutants such as “carbon monoxide (CO),” “volatile organic compounds (VOC),” “nitrogen oxides (NOx),” “particulate lead,” beside emissions of “water vapor” as well as “carbon dioxide” are the most common emissions of petrol. Large vehicles are widely used diesel; besides that, passenger cars depend on diesel occasionally. Diesel engines are more fuel-efficient and emit less carbon monoxide emissions [21]. Urban transports are the major source of this pollutants. Pollutants such as "photochemical smog" are the inferred of some primary pollutants that are chemically reacted, like ("the vac and nitrogen oxides"). It should be noted that harmful substances during the operation of mobile vehicles enter the air in volumes that depend on the operating modes of the engines. Here the conditions of motor transport exploitation and the relief of the road play a major role. For example, during acceleration and braking in exhaust gases, the content of carbon monoxide increases by almost 8 times. The minimum amount of carbon oxide is emitted at a uniform vehicle speed of 60 km/h. In addition to meteorological factors for self-cleaning of the atmosphere, some components of noxious emissions from road transportation are involved in the process of interaction with air environment components, resulting in generation of new noxious substances “secondary air pollutants”. When considering the environmental impact of certain types of vehicles, it should be noted that the dominant share of emissions (54 %) of all harmful substances belongs to trucks. About 50 % of lead compounds enter the atmosphere from cars and two-thirds of nitrogen dioxide comes from trucks [22].

4.1.2. Emissions types [23]

- Nitrogen oxides (NOx): NOx is a general term describing the group of NO, NO2, and other nitrogen oxides. NOx is a gases collection, plays a crucial role in ozone formation. The majority of these gases are colorless and odorless, unlike the NO2 feature that is brown. They are primarily formed during the combustion of fuel, particularly at elevated temperatures, when a small amount of nitrogen from the air is burned by engines, as well as nitrogen compounds emitted by automobile fuels. Because diesel engines have higher combustion temperatures, they produce more NOx than gasoline engines. NOx can irritate the airways, causing lung disease. NOx is also a precursor to smog-forming compounds like ozone (O3).
- The Particulate Matter (PM): PM is classified as either a primary or secondary pollutants. Dust and black carbon are "primary" particles that come from a variety of sources, including “passenger cars”, “trucks”, “buses”, “factories”, and “construction sites”. The Chemical reaction with some other emissions can produce "secondary" particles. They are created when gases from the combustion of fuels, like those found in automobiles react with light from sun and vapor of water in an indirect way. PM2.5 generally refers to the "fine" particles that have a diameter of equal or less than 2.5 μm. PM10 is all of the particles that have a diameter equal or less than 10 μm (about 1/7 of a human hair diameter). Engines that use diesel produce significantly more particulate matter (PM) than those that use gasoline. Fine particles can inhaled into human lungs, Symptoms are becoming more severe in people that suffering from respiratory or cardiovascular problems. Many organizations such as “World Health Organization (WHO)”, “United States Environmental Protection Agency (USEPA)”, and “California Air Resources Board (CARB)”,
consider diesel Particulate Matter to be more toxic than gasoline Particulate Matter and a possible human carcinogen.

- Volatile Organic Compounds (VOCs): VOCs are a lot of compounds. Results from imperfect combustion of fuel. And others from the fuel evaporation, particularly when refueling. Because of the high volatility of the fuel, VOCs from Gasoline engines are higher than diesel engines. VOCs have a wide range of toxicity, and many are ozone precursors.

- Sulphur Dioxide (SO2): SO2 is an emission that comes from the combustion of sulfur found in the fuel. Diesel engines produce the most SO2 because they contain more sulphur than gasoline engines.

- Ozone: The increase of nitrogen oxides and hydrocarbons concentration under solar radiation generates photochemical smog (ozone, PAN, etc.) Background ozone concentration in nature is 20–40 Advances in Health Sciences Research, volume 28 234 mct/m3. At 200 mct/m3 there is a noticeable negative impact on the human organism[24]

- Carbon Monoxide (CO): CO is produced when fuels are burned incompletely in a vehicle, especially at low temperatures. Due low temperature of combustion of gasoline engines in comparison to diesel engines, they produce more CO. Carbon monoxide has the effect of lowering oxygen levels in the blood. CO can be fatal at extremely high levels, but these are not found outdoors. As previously stated, high levels of CO are commonly found in the cold months, particularly at night, because of the inversion of temperature. Vehicles account for roughly 60% of CO emissions [25]. Lead, toxins, coolants, and other pollutants are also released by vehicles, including “benzene”, “butadiene”, “soot”, “acrolein”, and “formaldehyde”. A lot of the components are VOCs, and the other components are particles. Newer vehicle refrigerant (R134a) is still considered a GHG pollutant. During vehicle refueling, emissions like hydrocarbon (HC) vapors are produced by the storage and distribution of vehicle fuels.

4.1.3. FACTOR AFFECTING EMISSIONS

Several variables affect transportation Emissions. These variables are categorized as follows: • traffic volume
  • functional characteristics of roads
  • speed
  • road characteristics
  • vehicle characteristics and other factors

4.1.3.1 EFFECTS OF TRAFFIC VOLUME [26]

Along the road sections where traffic volumes are not significantly different, emissions depend on traffic composition with heavy vehicles (trucks and buses) having a noticeable effect on the emission of gaseous pollutants; a high percentage of heavy vehicles in traffic composition has a significantly negative effect on emissions, while two-wheelers hardly affect total traffic emissions. Concerning the traffic characteristics, traffic volume plays the main role in the emission of gaseous pollutants from the vehicles, as in all cases emissions rise accordingly to the traffic volumes. An important observation is also that along the road sections where traffic volumes are not significantly different, emissions depend on traffic composition with heavy vehicles (trucks and buses) having a noticeable effect on the emission of gaseous pollutants; a high percentage of heavy vehicles in traffic composition has a significantly negative effect on emissions, while two-wheelers hardly affect total traffic emissions.

4.1.3.2 EFFECTS OF FUNCTIONAL CHARACTERISTICS OF ROADS [26]

Regarding the functional characteristics, the emissions are proportional to the road category. More specifically, emissions are particularly high on main arterials, while on secondary arterials emissions are generally limited. In addition, the road direction has a serious impact as most of the unidirectional roads have more limited emissions than bidirectional roads because the former support the development of higher and more stable speeds and facilitate decongestion resulting in lower emissions. Moreover, the existence of a traffic-control island separating the two directions supports higher and more stable speeds and reduces
emissions. More lanes per direction favor higher volumes, but also the development of higher speeds during off-peak periods. Road segments with lower traffic volumes, even with only one lane per direction can support higher speeds, undisrupted vehicle flow, and lower emissions. It should be noted that illegal parking reduces the effective width of the section of the road drastically, contributing to increased congestion and emissions. Moreover, it was observed that the existence of bus lanes in road segments contributes to the smooth flow of traffic and the reduction of greenhouse gas emissions. More specifically, it was observed that along with road segments where the bus lane was illegally occupied by parked vehicles, buses had to interfere in the general traffic, causing more cases of traffic saturation, lower speeds, and overall higher emissions. The existence of signalized intersections combined with high volumes contributes to high traffic emissions as vehicles are subjected to decelerations and accelerations (stop and go). However, the existence of signalized intersections, when configured adequately to facilitate a smooth traffic flow, lead to lower air pollutant emissions due to the maintenance of stable vehicle speeds, while misconfigured signalized intersections, in conjunction with high volumes, contribute to high traffic emission as vehicles undergo frequent decelerations and accelerations (stop and go).

4.1.3.3. Effects of speed
In highway geometric design, design speed is an important parameter that influences other design features. There is a direct correlation between vehicle speed and acceleration and fleet emissions. CO and HC levels rise as speed rises from 15 to 32 km/h. CO and HC concentrations, on the other hand, drop slightly as speed is increased from 32 to 53 km/h. NO emissions, In contrast, steadily and clearly increase over the same vehicle speed range. In spark-ignition engines, the rate of exhaust flow increases dramatically through acceleration, resulting in a total emission rate increase by a net amount. A linear correlation is used to describe the relation between CO and HC concentration in tailpipe exhaust and acceleration. [27] The fuel consumption and emission change according to speed rate: for idling rate ≤ 50% of total emission, for accelerating rate = 35-40% of total emission and for decelerating rate ≤ 10% of total emission. [28] Traffic speed is another important traffic characteristic which significantly influences traffic emissions. More specifically, emissions are reduced when regular traffic flow increases along with vehicle deceleration and acceleration (stop and go). Thus, it is of critical importance to maintain normal and stable driving speed along urban roads and to facilitate the decongestion of the network.

4.1.3.4. Effects of road characteristics [29]
In the geometric design the alignment of roads is critical in either the way is straight horizontal or flat vertically. The best alignment of road that can carry more traffic at any given speed. In the highway geometric design process, the alignment can be classified into vertical and horizontal alignments.

4.1.3.4.1. Horizontal Alignment
With superelevation rate and side friction factor, in the horizontal alignment design it's must be balancing between curvature and design speed. Design speed increases as the curvature radii and superelevation increase. Based on design speed and superelevation rate, Green Book suggests a horizontal curve radius. To ensure that the traffic operates safely and efficiently on the curve, On curves particularly a horizontal one, the design speed should be based on minimizing variance in operating speeds. (David L.C 2018) developed a regression model showing that as the Curvature Change Rate (CCR) rises, CO2 emission rates rise as well. According to The Equations, Lower "CCR" indicates that the segment of the road is primarily made up of curves which are either tangents or flat, enabling the driver to operate at high speed with no need to accelerate heavily; furthermore, a design of road with high "CCR" controlling the driver geometrically and, as a result, greater accelerations at low speeds. A road with a higher CCR value controls the driver and, thus, greater accelerations at lower speeds. A relation with the "means of average speed" and the deviation of the average speed with the value of CO2 emissions was found. The CO2 emission rate is higher for lower speeds [30].
4.1.3.4.2. Vertical Alignment
Vertical alignment encourages the driver to operate uniformly through highways in terrain that includes elevation change. Vertical alignment requires a design with suitable grades, mitigating the speed reduction, and fulfilling stopping sight distance needs. Mostly, passenger vehicles can operate on grades that include 4-5% steepness without any considerable reduction in speed. [31]. Trucks emit more than six times of PM2.5 amount, NOx, and CO2 when compared from 0% to 9% of grades. 9% of grades increase the amount of CO by 3 times and 4 times of HC compared to a flatly grade for 27 other emissions, including CO and HC. Finally, as expected, grades had a significant impact on vehicle emissions. [32]

4.1.3.5. Vehicle Characteristics and Other factors
The characteristics of vehicles are the primary factors that affect fuel economy, such as the size of the engine, the weight of the vehicle, vehicles technologies. Large and heavy vehicles, automatic transmissions vehicles also the vehicles of special requirements (e.g., power seats and windows, power brakes and steering, and air conditioning), these vehicles needs and consume fuel more than vehicles without these needs. Fuel consumption can rise by as much as 40% if vehicles are not properly maintained. 10% increase in average fuel consumption due to the improper tuning of the vehicles engine, and even a 2 mm wheel misalignment can cause a 3% increase in fuel consumption because of the resistance of tire rolling. Weather conditions have a significant impact on fuel economy. Low temperatures and high winds increase fuel consumption, resulting in aerodynamic losses. In Europe, for example, fuel consumption in the winter is 15 to 20% higher than in the summer. [33]. The presumption that vehicles of all household are the same kind, frequently, supposed to be passenger cars, is a common misunderstanding in operational emission modeling frameworks. The age of the car and its type are essential factors in the modeling of emissions, as they usually possess a lot of elements linked to the generation of emissions. Include the improvement of engine technology (make the engine more efficient), the technology of emission-capture, and aging effects on the performance of vehicles. (Ya-Wen K. 2006), investigated impacts of vehicles model on averages emissions of fleet. It implies that older vehicles emit a lot of pollution and contribute greatly to overall emissions of fleet. The variation trends with model year, on other hand, are unaffected by characteristics of site, and the age of vehicle effects on NO, HC, and CO emissions is comparable [34]. When developing emission inventories for areas and cities with large temperature differences through seasons summer and winter, the season becomes a significant factor to consider. Under winter conditions, the emissions rates, particularly the surplus from the start, tend to change significantly, with start contributions reaching more than 50% of overall on-road emissions. [35]. Choi et al. (2010) investigated the susceptibility to the temperature of NOx, HC, and CO emissions in petrol and diesel vehicles. Across all pollutants, vehicles that use gasoline have high sensitivity to temperature than vehicles that use diesel. Vehicles that use diesel were a little bit more sensitive to cold temperatures than vehicles that use gasoline, in terms of NOx emissions. For diesel, relative sensitivity varies by calendar year. However, there was a more regular trend: since vehicles had become cleaner in later calendar years, the temperature sensitivity for NOx, CO, and HC increased. Varies in emissions as a percentage of temperature change. (Choi and colleagues, 2010) [36]. Similarly, for petrol and diesel vehicles, the sensitivity of CO, HC, and NOx emissions to humidity was investigated. NOx emissions are influenced by the direct effect of adjustment of humidity and the indirect effect adjustment of air conditioning. Because the humidity correction coefficients for gasoline and diesel were different, the sensitivity of the vehicle is a little bit different – vehicles that use gasoline are more susceptible to humidity, though the differences were minor. An adjustment of humidity and air conditioning were used for temperature greater than 75°; also for temperature between 25° and 75°, only the direct effect of humidity correction was used; and for temperatures less than 25°, emission estimates were not sensitive to humidity. Only the indirect effect of humidity through air conditioning adjustment applies to HC and CO in both gasoline and diesel for temperatures greater than 75°; there was no humidity effect for temperatures less than or equal to 75°. (R.L. Mc Cromic. 1997) investigated the relationship between NOx, CO, and PM
emissions and humidity, finding that NOx emissions were higher at lower humidity levels throughout the test cycle, but that humidity had no effect on CO and PM emissions. [37]

4.1.4 TRAFFIC FLOW LIMITS

The Ambient Air Quality Standards offered by the WHO is as follows:

| Pollutants | Time            | Concentrations (µg/m³/or ppm) |
|------------|-----------------|-------------------------------|
| PM₁₀       | Annual mean     | 20 µg/m³                      |
| PM₂.₅      | Annual mean     | 10 µg/m³                      |
|            | 24 hour mean    | 25 µg/m³                      |
| O₃         | 8 hour mean     | 100 µg/m³                     |
| NO₂        | Annual mean     | 40 µg/m³                      |
|            | 1 hour mean     | 200 µg/m³                     |
| SO₂        | 24 hour mean    | 20 µg/m³                      |
|            | 10 minutes mean | 500 µg/m³                     |
|            | 15              | 90 µg/m³                      |
| CO         | 30              | 50 µg/m³                      |
|            | 1 hour          | 25 µg/m³                      |
|            | 8 hour          | 10 µg/m³                      |
| Pb         | Annual mean     | 0.5 µg/m³                     |

Also, The National Ambient Air Quality Standards offered by the EPA is as follows:

| Pollutants        | Primary/ Secondary | Averaging Time | Levels | Forms                                      |
|-------------------|--------------------|----------------|--------|--------------------------------------------|
| Carbon monoxide   | Primary            | 8 hours        | 9 ppm  | not to be exceeded more than once per year |
|                   |                    | 1 hours        | 35 ppm | not to be exceeded                        |
| lead (pb)         | Primary and secondary | Rolling 3 months average | 0.15 µg/m³ | not to be exceeded |
| Nitrogen dioxide  | primary            | 1 hour         | 100 ppb | 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
|                   | primary and secondary | 1 year        | 53 ppb | annual mean                               |
| Ozone (o3)        | primary and secondary | 8 hours       | 0.070 ppm | annual fourth-highest daily maximum 9-hours concentration, averaged over 3 years |

| Pollutants (pm)   | Primary/ Secondary | Averaging Time | Levels   | Forms                                      |
|-------------------|--------------------|----------------|----------|--------------------------------------------|
| PM₂.₅             | primary            | 1 year         | 12.0 µg/m³ | annual mean, averaged over 3 years         |
|                   | secondary          | 1 year         | 15.0 µg/m³ | annual mean, averaged over 3 years         |
|                   | primary and secondary | 24 hours     | 35 µg/m³  | 95th percentile, averaged over 3 years     |
| PM₁₀              | primary and secondary | 24 hours     | 150 µg/m³ | not to be exceeded more than once per year on average over 3 years |
Traffic emission models

Emission models are the methods for calculating pollutants regarding the factors of emission, average speed, consumption of fuel, also the number of vehicles on the defined type of roads. There are three different classifications of vehicular emission models. A- static modeling or average speed-based emission models, B- dynamic modeling, and C- Regression-Based Models. These models have all contributed new thing to models of vehicular emission: acceleration and non-exhaust emission rates modeling using special accession, representation of the anomaly of lowering CO2 concentrations, taking into account the characteristics of the drivers in acceleration modeling, also generalizing cycle of the drive into synthetic drive cycle. It has been observed that lately mostly modal models are sophisticated. Nonetheless, modal models should also account for the impact of cold start and drivers’ characteristics, where possible, an enhancement to all sorts of fuel and types of vehicles. In majority, acceleration is accounted, not always in the connection with a grade of the roadway, which also has an important impact on emission emitting [38].

5.1. Static modeling or average speed-based emission models [39]

- “MOBILE6” model, that established by “EPA”, used over the States by exception of California city.
- “The Motor Vehicle Emission Inventory (MVEI)” model established by “California Air Resources Board (CARB, 1996)”.
- (COPART) III “computer programme to calculate Emissions from Road Transport” model (Ntziachristos and Samaras, 2000). “COPERT III” is a component of “CORINAIR”, the program supported by “European Environmental Agency”, creates a set of programs techniques to assist European countries in compiling annual air emission inventories.

5.1.1. (MOBILE 6) model

MOBILE6 is a software calculates emission factors for hydrocarbon (HC), carbon monoxide (CO), nitrogen oxides (NOx), exhaust particulate matter (which is made up of several components), tire wear particulate matter, brake wear particulate matter, sulfur dioxide (SO2), ammonia (NH3), six hazardous air pollutants (HAP), and carbon dioxide (CO2) for vehicles that use gasoline and diesel fuel, as well as some specialized vehicles, such as vehicles that use natural-gas-fuel. Estimates of MOBILE6 emission factors are affected by a variety of factors, including temperature in the environment, travel speeds, modes operation, volatility of fuel, and rates of mileage accrual. The user can control a lot of variables that affect emissions of vehicles. MOBILE6 can calculate factors of the emission for any calendar year from 1952 to 2050. Each calendar year, vehicles from the 25 most recent model years are considered to be in use. [40]

5.2. Dynamic modeling

During chassis dynamometer tests, emissions are continuously measured and stored for specific time intervals in the dynamic approach (frequently each second). The conditions of operation of vehicles at a specific time, and that are defined by the speed values, recorded at same time as emissions. The speed-time curve is then used to calculate the accelerations. Speed of the Engine, position of the throttle, airflow mass, the use of air conditioning, and transmission gear are all examples of more comprehensive measurements. Instant measurements enable both instant and modeling and modal analysis, according to instant variables of vehicle kinematic, like speeds and accelerations or more aggregated modal variables like acceleration.
mode time, cruise mode, and idle mode, respectively. Dynamic models can be divided into: emission maps, regression-based models, and load-based models. [41]

5.2.1. Emission Maps

Emission maps models, likewise known as velocity-acceleration (VA) lookup tables, are matrices with one dimensional ranges of speed and the other dimensional acceleration or particular ranges of power. For emission species and category of vehicle, one cell of emissions matrix is specified to instantaneous emission measurements, based on vehicle speed and acceleration measured at the time. The mean of all emission measurements is then calculated for each cell. Emission maps, while simple to create and use, have a lot of drawbacks. They can be scattered, and the cycle of driving that is used to populate them can have an impact (Sturm et al., 1998). Furthermore, they are frequently inflexible, failing to account for factors such as the grades of road, use of accessories, or historical effect. a few of the factors can be represented by creating an emission map library, defining matrix filling circumstances, adding multiplicative factors to be applied after using the matrices. Emission maps are often used, Europe in particular, due to their simplicity. Hickman et al. (1999) and Sturm et al. (2001) made a comprehensive examination of emission maps, as well as a discussion of their limitations and applicability. (1998). Sturm et al. (1998) look into the requirements that driving cycles must meet in order to produce acceptable maps, the influence of data aggregation and interpolation methods, and the requirement for additional parameters to account for driving behavior dynamics. [42]

5.2.1.1. Modem emission database

The MODEM emissions database was established as part of a large EC project aimed to develop a greater understanding of actual vehicle fuel consumption and exhaust emissions. Three countries are taking part in this program; Great Britain with TRRL (Transport Road Research Laboratory, currently TRL), the Federal Republic of Germany with TUV Rheinland, and France with EGRETS (Institut national de Recherche sur les Transports et leur Securite). A set of testing cycles was produced through the statistical analysis of the operation conditions of vehicles and repeated on a vehicle test bench (chassis dynamometer) to measure the pollutant emissions of vehicles. The results of these laboratory tests lead to models being developed that related exhaust emissions and fuel consumption to instantaneous speed and acceleration. Although almost a decade old, the MODEM database is still, to date, the most detailed and comprehensive emission inventory available for the UK vehicle and is the only readily available source of information on the effect on the emission of instantaneous traffic characteristics. [43] The emissions of HC, CO2, CO, and x NO are measured by the use of emission maps model for twelve vehicles of different types, With a range of speeds from 0 to 90 km/h, and the acceleration product and range of speeds from (–15) and (+15) (m2/s3). [44]

5.3. Regression-Based Models

5.3.1. (Georgia Institute of Technology ) Model

Georgia model created for Atlanta, Georgia in the metro region, as part of the MEASURE project. It's a statistical aggregate trip-based model that can be used to forecast or measure traffic activity. Thus This model is used for predicting the average emission rates per second over the course of a trip or driving cycle, rather than instantaneous emissions. On data related to the cycle of driving, least-squares regressions are included in this model. The rate of emissions (for CO, HC, and NOx) standardized to the FTP bag 2 emission mean rate is the estimated variable. Using a tree-based hierarchical regression technique, explanatory variables are chosen from the variables sets: - modal variables such as average speed and
percentage of cycle exceeding various positive kinetic energy, power, and acceleration thresholds, interaction dummy variables derived from vehicle characteristics such as odometer readings, fuel injection type, catalytic converter type, and high/normal emitter status. Even though only a few vehicles from recent model years are shown. A large database is used to calibrate the model containing over 13,000 test vehicles, which increases its statistical significance. The data were weighted for the calibration to reflect the Atlanta fleet's model year distribution. The Georgia Institute of Technology model, it's not calibrated to each category of vehicle technology separately. Instead, it explicitly represents vehicle technical specifications and status within the regressions. As a result, it is more efficient. Regardless of its advantages, the model of Georgia Institute has a few drawbacks. Firstly, difficult to make a design or calibration because a lot of derived variables should be calculated and offered to the model in order to adapt the model to other urban areas. Secondly, the model only predicts trip-based emission rates rather than instantaneous emission rates, limiting its applicability to microscale studies. Finally, the model is location-specific because the model year distribution is factored into the calibration coefficients. [45]

5.3.2. Poly
"POLY" model was created and bullied by the researchers of Polytechnic University in New York City and the University of Texas. With the instantaneous acceleration and speed, POLY model uses linear least squares regressions to account for past accelerations and road grades [46]. The following is the model's formulation: [45]

\[
e_{i}(c,t)= \beta_0 + \beta_1 v(t) + \beta_2 v^2(t) + \beta_3 v^3(t) + \beta_{11} T'(t) + \beta_{12} T''(t) + \beta_{13} A(t) + \ldots + \beta_{19} A(t-9) + \beta_w W(t)
\] (1)

\(e_{i}(c,t)\) is the rate of emissions for species \(i\), that depends on the category of vehicle \((c)\) and time \((t)\);
\(v(t)\) is the speed at time \((t)\);
\(T'(t)\) is the duration of acceleration since its inception up to the current time \(t\);
\(T''(t)\) is the duration of deceleration since its inception up to the current time \(t\);
\(A(t-t)\) is the combined acceleration or deceleration at time \(t-t\) \((0,9)_t=\),

\[
A(t-t)=a(t-t)+9.81\sqrt{\frac{g(t-t)}{1+g(t-t)}}
\] (2)

The product of \(v(t)\) and \(A(t)\) is \(W(t)\)
\(\beta s\) are the parameters that calibrated for each vehicle category \(c\).

(NCHRP vehicle emissions database) were used in this model. Furthermore, “FTP” data, used for model calibration, while MEC01 and US06 data were used for validation purposes. The results of some vehicles compared with CMEM and with the Virginia Polytechnic Institute model results.

5.4. Load-Based Mod

5.4.1. CMEM
A comprehensive modal emission model for light weight cars and trucks is currently being sophisticated. To serve as the model's foundation, more than three hundred real-world vehicles are being gathered for in-house dynamometer testing under as-is conditions. Under a variety of driving conditions, the model is designed to predict tailpipe emissions second by second. Individual vehicles, as well as composite vehicles representing various vehicle technology categories, can be modeled with properly functioning, deteriorated, or malfunctioning emission control conditions. The model is made up of six modules that predict engine power, engine speed, air/fuel ratio, fuel use, engine-out emissions, and catalyst pass fraction using a simple
parameterized physical approach. The model takes into account four important vehicle operating conditions: cold and warm starts, normal, stoichiometric operation, high-power enrichment, and lean-burn operation. The model concept is discussed, as well as the model's expected input/output requirements. The general structure of the model is also presented, with an emphasis on emissions for vehicles operating in hot-stabilized conditions. The preliminary results of the model are presented, and comparisons between the modeled and measured results for 17 different vehicles are made. The preliminary findings indicate a high level of agreement. [47]

The CME Model (Comprehensive Modal Emissions Model) was established at the California University, Riverside, and Michigan University. The model was calibrated by use of "NCHRP" (NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM) database, which was created by UC Riverside. second-by-second speed measurements are included in the database, as well as the rates of CO, CO2, HC, and NOx emissions from engines on three driving cycles: (the FTP, US06, and an engineered) cycles, which are referred to as Modal Emission Cycles (MEC01). This test involved about 300 vehicles (passengers and light trucks) divided into 26 categories. (1) demand of power, (2) speed of engines (3) ratio of air/fuel (4) fuels rate (5) emissions of engine (6) catalyst pass fraction are six modules that make up the CMEM. The user defines the vehicle fleet's composition, as well as each vehicle's category and second-by-second speed trajectory. There are options for soak time, acceleration, road grade, and accessory use. On a second-by-second basis CMEM calculates fuel consumption as well as emissions of CO, HC, NOx, and CO2 from tailpipes. When given stoichiometric, cold-start, enrichment, and element conditions, the model compares the vehicle power demand to thresholds to determine which of these conditions the vehicle is operating in. The model also includes cold and intermediate soak time starts. For the 26 vehicle/technology categories, CMEM was calibrated using FTP bag 1 and bag 2 data, as well as MEC(01) data. FTP bag 3 and US06 data were used for validation [48].

6. Traffic noise

Many factors contribute to increased road traffic noise, particularly on highways, including noise generated by a vehicle's engine, exhaust, tire contact with the road surface, and interaction between moving vehicles and passing air, road condition and traffic management, vehicle speed, and traffic composition. (the noise increased due to a change in speed rate). For the space dimension of the roadway, the noise increase by decreasing the width of the road and increasing the building height [49]. The big vehicle (like buses and trucks with diesel fuel) causes traffic noise equal to 115% of that of small cars (benzene fuel) [50]. In urban areas, transportation is the significant source of noise. More than 60% of the sites investigated by (Hothershall and Salter) had traffic flow as a main source of noise. For transportation planning, the extent to which urban traffic activities and traffic jams contribute to pollutants and energy consumption is critical. As a result, models and methods that link the movements of the traffic and the conditions of the travel to environmental and energy variables are necessary [51].

6.1. Traffic noise limits

The noise Standards limits offered by the WHO is as follows:

TABLE 3. noise Standards limits (WHO)

| S1.NO. | LOCATION                           | NOISE LEVEL db(A) |
|--------|------------------------------------|-------------------|
| 1      | RURAL                              | 25-35             |
| 2      | SUBURBAN                           | 30-40             |
| 3      | RESIDENTIAL (URBAN)                | 35-45             |
| 4      | URBAN (RESIDENTIAL AND BUSINESS)   | 40-50             |
| 5      | CITY                               | 45-55             |
| 6      | INDUSTRIAL AREA                    | 50-60             |
6.2. Traffic noise aspects

6.2.1. Road traffic noise indicators
Almost exclusively, road traffic noise disturbance is assessed using standardized outdoor noise exposure indicators [52]. One of the most common noise indicators is the weighted equivalent continuous sound pressure level in the particular daytime or over 24 hrs. This indicator used by the regulatory authorities in assessment guidelines and legislation [53]. Standard indicators such as the (day-night and day evening-night levels) underline equivalent continuous sound levels during several periods when people are likely at home [54]. Standard indicators of traffic noise, on the other hand, are insensitive to distinguishable traffic noise events [55] and temporal noise profile variation [56]. A recent meta-analysis found significant variation in community response to road traffic noise, which was attributed to the use of a standard noise indicator as the sole predictor of adverse effects [57]. Distinctive noise characteristics that can further differentiate traffic noise impacts across communities are thought to be important for epidemiology and pollution management [58]. To complement the use of an equivalent sound level over 24 hours, Bradley and Jonah [59] showed that using the difference in daytime and night-time equivalent sound levels increased the variance explained for subjective community responses corresponding to annoyance and elicited sleep disturbance. Road function is more commonly utilized as a supplementary indicator to differentiate nighttime road traffic noise impacts across communities [60]. The basis for using road function to complement the use of standard noise indicators is that a road mainly fulfilling long-distance transit function is generally regarded to have proportionally greater night-time traffic than a road that services local traffic movements [61]. To address the fact that traffic noise levels fluctuate with time, event-based supplementary traffic noise indicators have been developed [62]. Event-based indicators consider the maximum noise level or sound exposure level, both of which are encouraged for use in the WHO Night Noise Guidelines for Europe for characterizing sound events [63]. Wunderli et al., in particular, developed a method for calculating Individual noise events above a general noise level from transportation sources are considered when calculating exposure to intermittent transportation noise. Brown and De Coensel [64] presented an algorithm for quantifying emergence as the number of individual noise events in a traffic flow that exceeds a threshold noise level, where the threshold level can be fixed or adapt to dynamic changes in the general noise environment. An equivalent sound pressure level for the nighttime period was calculated to assess the number of events and sound exposure levels associated with heavy vehicles. [65]. Despite the fact that supplementary noise indicators have the potential to improve road traffic noise impact assessments, they have not been widely used due to the complexity of implementing them with conventional noise models or the multicollinearity associated with high correlation between standard and proposed supplementary indicators [66].

6.2.2. Effects of speed
There is a link between traffic noise and speed that can be measured. Reduced speeds of 6 mph in urban areas with speeds of 20 to 35 mph would reduce noise levels by up to 40%. Reduced speeds of 70 mph and 60 mph on urban highways would reduce noise by up to 50%. [67]

6.2.3. Effects of flow
High traffic flow can impacts air and noise pollution in addition to causing congestion. Noise is produced not only by passing motor vehicles, but also by friction between the road and vehicle tires, as well as vehicle horns. At some levels, these noises can still be tolerated by society, in the sense that the sound caused still does not cause a disturbance of comfort and other disturbance to the community, but at a higher level, the sounds caused by the vehicles can already be said as an annoyance called noise or noise pollution. The rapid growth of transportation and the use of larger, powerful engines produce undeniable noise from our lives and is a danger to life. The goal of noise control is to create a comfortable acoustic environment, whether indoors or out. So, the intensity and nature of all sounds in and around the building will be by the wishes of users. Noise is defined as an 'unwanted sound', considered a trigger and an environmental disturbance. Traffic noise is the most significant source of environmental disturbance, and long-term
disruption is thought to be harmful to health. Furthermore, traffic noise has a strong influence on the comfort and value of land use; it has been discovered that increasing noise value can affect the declining value of a property in the areas. The greater the use of transportation services in urban areas, the greater the congestion in the region. When motor vehicles are thoroughly examined, the noise produced by the engine, type of motor fuel, type of cooling fan, exhaust gas system, suction from the carburetor, tire type (standard or radial), and vehicle form will be determined. The noise from transportation begins the benchmark of augmentation of disturbed people in comparison with others like congestion and pollution. Based on “Montreal” research, there was a relation between the levels of noise and the noise disruption of traffic and environment. Such noise is known to be influenced by several factors, one of which is the distance from the noise source. Distance to the main road and the type of road is a strong predictor of noise disturbance. The distance from the noise source has a significant effect on the noise level, which decreases to a constant tending of the noise level as the distance increases [68 ].

6.2.4. Traffic volumes
Noise has an impact. The noise produced by two hundred vehicles passing in one hour is half that of two thousand vehicles. As a result, volume reductions must be significantly happened to have a good effect. By making a reduction in the total noise events, even a small reduction in traffic could improve noise levels. However, the reduction in speed is critical. With a drop in vehicles numbers, Noise won’t automatically fall if it simply let the rest of the traffic speed up. [69 ]

6.2.5. Traffic mixture
In both overall noise and noise peaks, is a significant factor. Heavy vehicles, mopeds, and motorcycles make a lot of noise. At 30 km/h (19 mph), a single high weight vehicle (heavy vehicle) can produce noise equal to what 15 cars can produce. Low weight vehicle (light), predomine on traffic noise as they account for the majority of flow of the traffic. Cars are usually predomine the noise level Even there is a high percentage of heavy traffic, because of their high speeds. [69 ]

6.2.6. Braking and Accelerating
Noise peaks and overall traffic noise can be influenced. A disproportionate impact on noise perception can occurred due to the Noise results from aggressive driving stand out from the background. Vehicle Acceleration is more important than vehicle braking, and it is more so at low speeds. Traffic noise can be accounted for by 10% of acceleration. [69 ]

6.3. Traffic noise models
6.3.1. Basic statistical models
One of the first ever models, It was created in 1952., its described in the Acoustic Noise Control Handbook [70]. Based on this model, the 50th percentile of traffic noise occurs at speeds between 35-45 mph (approximately 55-75 km/h) and distances greater than 20 feet (about 6 meters)is given by:

$$L_{50}=68+8.5\log(Q)-20\log(d)$$

(3)

( Q ) is a traffic volume in veh/hr while (d ) is the distance in feet from the point of observation to the center of the traffic lane; no vehicle or road type specifications are included. Later, Johnson et al. [71] proposed a new TNM that included the mean speed of vehicles in mph. L50 expression is as following:

$$L_{50}=3.5+10\log \left[ \frac{Qv^2}{d} \right]$$

(4)

For heavy vehicles percentage ranging from zero to 40 %, this model shows good agreement with experimental data. It also contains corrective factors for some gradient and ground attenuation. Galloway
et al. [72] enhanced this model by accounting high weight vehicles percentage (P). The expression for the L50 level in dBA was:

$$L_{50} = 20 + 10 \log \left( \frac{Qv^2}{d} \right) + 0.4P$$  \hspace{1cm} (5)$$

French “Centre Scientifique et Technique du Batiment” (C.S.T.B.) formulated a model [73], which proposed an equivalent emission level prediction formula based on the average acoustic level (L50) with this expression:

$$L_{eq} = 0.65 L_{50} + 28.8 \text{ [dBA]}$$  \hspace{1cm} (6)$$

(L50) is measured taking into account only the equivalent vehicular flows (Qeq) and is given by: [74]

$$L_{50} = 11.9 \log Q + 31.4 \text{ [dBA]}$$  \hspace{1cm} (7)$$

for urban road and highway with vehicular flows lower than 1000 vehicles/hour;

$$L_{50} = 15.5 \log Q + 10 \log L + 36 \text{ [dBA]}$$  \hspace{1cm} (8)$$

6.3.2. England standard: Cortn Procedure
CORTN method (Calculation of Road Traffic Noise) was established in 1975 by the laboratory of transport and road research and with the transport department in UK, after that this procedure modified in 1988 [75]. On both a 1h and an 18h reference time, it calculates the basic noise level L10. L10 is calculated at 10 meters from a highway's nearest edge. Flow and the composition of traffic, mean speed, road gradient, and road surface type are the parameters involved in this model. The primary hypothesis is a moderate velocity of wind and a road surface that has been dried. At 10 meters distance from the nearest carriageway,

Hourly noise level is predicted, according to this equation:

$$L_{10}(1/h) = 42.2 + 10 \log(q) \text{ [dBA]}$$  \hspace{1cm} (9)$$

The level of noise in terms of total 18 hrs flow is:

$$L_{10}(18/h) = 29.1 + 10 \log(q) \text{ [dBA]}$$  \hspace{1cm} (10)$$

where (q) - (Q) are the flow/hr (vehicles/hour) and the flow/18 hr (vehicles/hour), respectively

Conclusion
A high pollution index is linked to a high traffic volume within urban areas, both in terms of noise and air pollution. According to studies, pollution increases with the increase of traffic volume and durations that vehicles are stopped on the roads, while noise emitted by vehicles also increases, depending on the road surface type and conditions, as well as vehicle speed and acceleration. all that will increase the noise pollution index in the area. regardless of the assessment system, urban mobility measures for improving public transport supply and its infrastructure, developing infrastructure for cyclists, pedestrians, and people with special needs, employing the renewable sources of energy, information accessibility, and education
about the benefits of sustainable urban mobility are agreed to be the most efficient and tend to dominate in both theory and practice. These studies investigate the effects of flow on air and noise pollution, and they study the social, environmental, and economic aspects, looking forward to a "sustainable alternative". Below are some results from this research:

- The negative impact of transport on the environment has been considered developing transport infrastructure. This has further promoted the use of cars and increased their congestion thus causing several negative consequences, including inefficient economy, time loss, transport pollution, and traffic accidents.
- The main reasons leading to the current situation have occurred due to urban transport systems poorly designed for the needs of the urban area residents of all ages, social and interest groups because of lack of alternatives for traveling by car along the road sections where traffic volumes are not significantly different, emissions depend on traffic composition with heavy vehicles (trucks and buses) having a noticeable effect on the emission of gaseous pollutants; a high percentage of heavy vehicles in traffic composition has a significantly negative effect on emissions, while two-wheelers hardly affect total traffic emissions.
- Traffic speed is significantly influenced traffic emissions. More specifically, emissions are reduced when there is a regular traffic flow and increase along with vehicle deceleration and acceleration (stop and go). Thus, it is of critical importance to maintain a normal and stable driving speed along urban roads and to facilitate the decongestion of the network.
- Regarding the functional characteristics, the emissions are proportional to the road category. More specifically, emissions are particularly high on main arterials, while on secondary arterials emissions are generally limited. In addition, the road direction has a serious impact as the majority of the unidirectional roads, have more limited emissions compared to bidirectional roads, because the former supports the development of higher and more stable speeds and facilitates decongestion, resulting in lower emissions.
- The existence of a traffic-control island separating the two directions supports higher and more stable speeds and reduces emissions.
- Illegal parking reduces drastically the effective width of the section of the road, contributing to increased congestion and emissions.
- The existence of signalized intersections combined with high volumes contributes to high traffic emissions as vehicles are subjected to decelerations and accelerations (stop and go). However, the existence of signalized intersections, when configured adequately to facilitate a smooth traffic flow, lead to lower air pollutant emissions due to the maintenance of stable vehicle speeds, while misconfigured signalized intersections, in conjunction with high volumes, contribute to high traffic emission as vehicles undergo frequent decelerations and accelerations (stop and go).
- The major pollutants that are emitted from engines are: nitrogen oxides (NOX), carbon monoxide (CO), unburned hydrocarbons (CxHy), sulfur oxides (SOX), solid particles, including aerosols, as well as carbon dioxide or carbon dioxide (CO2) automobile transport accounts for about 50 % of the total amount of hazardous substances emitted into the atmosphere (in cities – up to 70 %).
- Motor engines annually emit into the atmosphere 20–27 million tons of carbon monoxide; 2.0–2.5 million tons of hydrocarbons; 6–9 million tons of nitrogen oxide; up to 190 tons of sulphur compounds; up to 100 thousand tons of soot; 13 thousand tons of heavy metal compounds; 200–230 million tons of hydrocarbon dioxide.
- The total volume of emissions of regulated harmful substances by the ATS fleet in terms of CO is about 300–400 million conventional tons per year
- One-third of the chlorofluorocarbons (CFCs), one-fifth of the carbon dioxide (CO2), and nitrogen oxides (NOx) half part of it, in ambiance, have resulted from transportations.
- Highways with high traffic flow have high noise levels compared to highways with low traffic flow. This is because the high vehicles number in the traffic stream.
The noise level of the outer lane was generally the loudest for both highways, resulting in overall OBSI levels of about 3 dBA differences between the outer and inner lanes of the highway. The level of transport noise in cities is unacceptably high, it reaches 70–75 dB (at the norm for residential premises 40–50 dB during the day and 30–40 dB at night). The sensitivity of a population to air pollution depends on a large number of factors, including age, gender, general health, nutrition, temperature, and humidity, etc. The elderly, children, the sick, smokers with chronic bronchitis, coronary artery disease, asthma are more exposed to the risk.

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