

“What are the effects of automotive air pollution
in densely populated areas?”

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Abstract

My main topic is how the automotive industry has affected air quality, how this affects health and what can we do about the problems it causes. My research aims to find the problems in the automotive industry that cause poor air quality so that more solutions can be made to make improvements in air quality worldwide. I am using statistics and news articles as my research. My conclusions were that the automotive industry is one of the largest factors when it comes to air pollution and while the solutions we have currently are good, we still need a lot more advancements to achieve an optimal level of air quality.

Introduction

The research topic I have chosen is the effects of automotive air pollution in cities and built-up areas. One of the main areas I am focussing on is the current solutions we have to help reduce air pollution. I am also focussing on how living in areas with poor air quality can affect health, especially while having respiratory conditions like asthma.

I believe that this research is worth doing because it will help outline one of the biggest problems faced in the automotive world. Doing this will also help me in my future practice as it will make me more conscious of ways to help larger communities with my designs rather than focusing on individuals. By compiling all of the effects of automotive air pollution I may also be able to design a solution to hopefully reduce or fix them.

I aim to highlight the causes of automotive air pollution in densely populated areas to bring awareness to the automotive industry. I will achieve this by analysing data from world research organisations. World research organisations will be a good place to look for data as I know they will provide correct information. I will also look at news articles to show the impacts of these causes on individual people in these larger communities.

I will start my inquiry with a methodology to show how I got my research, doing this early on will help the reader assess if the information that I have found is credible. Then I will move on to the results of my research as it will be the base of my investigation. The next part will be the main body which will be analysing and discussing the research. I will then make my solution to the

problems faced in the question I am answering. Finally, I will move on to my conclusion which will answer the main research question and will give my final reflection on what I have done.

Methodology

My main approach to this research is quantitative as most of my research will be based around world statistics. I feel like statistics from a reputable source will make my research more valid. I will also be looking a lot into news reports as I feel like this will give me some good evidence as to why this research is so important for the automotive industry. The method I will use for doing this research is through the internet. It is the best method of research for me as I will need as much up to date information as possible, especially when it comes to looking for statistics.

When I am analysing the statistics from my research I will compare historical data to modern data to show a clear picture of how the automotive industry has affected the air quality in populated areas over a certain time scale.

Results of my research

I am using the city of London as one of my main areas of research as there are a vast amount of reports that give data on the levels of air pollution. As historical data is important for this research, due to London having reports that go back a good amount of time, it is the perfect place for me to research. It is also one of the best cities to use as a baseline for cities across the world as they all seem to have some correlation to what is happening with London's air quality.

According to LondonAir, air pollution is not something that has recently occurred in cities like London as there was legislation attempting to control air pollution as early as 1306. However, this was not due to the automotive industry. The main cause of this air pollution up until the late 20th century was from wood and coal smoke used in manufacturing and wood fires.

In recent years, the pollutants in the capital's air have changed. This is primarily because of the decline in the use of coal in industry and domestic heating, which has led to large reductions in the emissions of sulphur dioxide and particles of soot over the past 40 years. As the automotive industry started to boom there was a massive increase in the amounts of nitrogen dioxide and small particles in the air.

On the 1st February 1994, the first report of the London air quality network was published for the analysis of air quality during 1993. At the time, however, there was no coordinated framework for monitoring London wide air quality. Without the collation of data, it was not possible to determine the quality of the air or to monitor trends in pollution. However, they did report the problems faced with what they could see. Some of the things that they had reported were that London Faced the challenge of traffic congestion, atmospheric and environmental pollution, high population density and crowding. Also, health data have shown an increased amount of asthma and other respiratory ailments amongst the population.

The second report for 1994 published in 1995 also had no data to prove how poor the air quality was, however, it was a growing consensus that air pollution in London was predominantly linked with traffic and that levels of pollution must be reduced through changes in transport policy. It claims that there was still a big increase in respiratory disease, especially asthma, but there was no evidence to prove that poor air quality was the cause of these diseases. It was accepted that pollutants worsen the symptoms of those who already suffer from these diseases.

The third report for 1995 published in 1996 was the introduction of more accurate data to show if pollutants exceeded the World Health Organization guidelines. The report contains information on the continuous air quality monitoring data collected on behalf of thirty-three local authorities in London and two local authorities in adjacent areas by the South East Institute of Public Health during 1995. It was broken down into the four quarters of 1995. In January nitrogen dioxide levels exceeded the World Health Organization guideline at several sites across the Network. In May a smog episode occurred and recorded the highest sustained ozone, nitrogen dioxide, sulphur dioxide and PM10 concentrations recorded during 1995. With this new way of mapping air pollutants, for nitrogen dioxide, there was an estimated error of between 2 and 25 per cent, as well as peak hour ozone levels to an accuracy of 10 per cent.

Moving to the London 2004 report, the year after congestion charges were introduced, there was a substantial improvement in air quality during that year. There was seen to be a decrease in nitrogen and nitrogen dioxide pollutants as well as a 30 per cent decrease in PM10 pollutants since 1996. There was however seen to be an increase of Ozone by 33 per cent. All monitoring

sites met the objectives for CO and SO₂. Since 1996 annual mean concentrations of CO and SO₂ decreased by over 50%.

In the most recent report for 2020, air pollution in London was at its best since the start of the century. 76 sites out of 86 that achieved the 90% data capture requirement met the annual mean objective for nitrogen dioxide (NO₂) of not exceeding 40 µg/m³. All sites achieved the hourly mean objective of no more than 18 occurrences of an hourly mean greater than 200 µg/m³. 56 of the 57 sites that achieved the 90% data capture requirement met the annual mean AQS objective of 40 µg/m³ for PM₁₀.

According to the World Health Organisation ambient air pollution accounts for an estimated 4.2 million premature deaths per year due to stroke, heart disease, lung cancer and chronic respiratory diseases. Top on their list of major sources of outdoor air pollution is fuel combustion from motor vehicles (e.g. cars and heavy-duty vehicles). One of the causes they believe is causing so much pollution from vehicles is poor urban planning, which leads to sprawl and over-dependence on private vehicle transport.

The Department of Food and Rural Affairs have shown the types of health effects from each of the major air pollutants. Nitrogen Dioxide, Sulphur Dioxide and Ozone have been shown to irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases. The effect of fine particles is that they can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases. Carbon dioxide affects health as it prevents the uptake of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.

A news report on the 21st April 2021 shows just how deadly air pollution is as it talks of a nine-year-old girl called Ella Adoo-Kissi-Debrah who lost her life in 2013 due to its health effects. She lived near the South Circular Road in Lewisham, south-east London and was the first person in the UK to have air pollution listed as the cause of death on their death certificate. Ella's mother called on the government to act on the coroner's recommendations, warning "children are dying unnecessarily because the government is not doing enough to combat air pollution".

There are many solutions in place to reduce air pollution, one of those being laws to reduce air pollution over a certain time scale. In the US, they were fueled to fix air pollution in the 1970s due to visible smog in many cities and industrial areas. Due to this visible smog, they decided to make the Clean Air Act. The Clean Air Act requires the Environmental Protection Agency to set air quality standards for several hazardous air pollutants reported in the Air Quality Index, requires states to have a plan to address air pollution and emissions reduction, and also addresses problems such as acid rain, ozone holes, and greenhouse gas pollution which is causing the climate to warm. Most industrialized countries have laws and regulations about air quality. The United Kingdom first passed its Clean Air Act in 1956 following a deadly smog event that killed many London residents. Due to China having one of the sharpest declines in air purity, they have had no choice but to set out several laws about air pollution, including a frequently updated five-year national plan to meet target reductions in air pollution.

Though these laws are helping with the decline of air pollution, the effects of air pollution are still there. While there is seen to be a reduction of these toxic air pollutants, the reduction is not coming fast enough and there is also the huge threat of climate change that goes hand in hand with some of these pollutants.

People are being told to help the solution of air pollution as individuals. One of the ways people are being asked to help out is by burning less coal. Burning coal has a larger impact on air pollution than burning oil or gas because it releases more carbon dioxide, sulfur dioxide, and heavy metal pollutants per unit of energy. Also, over one-third of the electricity produced in the world comes from burning coal. The aim is to try and make the majority of fuels cleaner and more renewable, for example, the use of solar and wind energy.

A second way people are being asked to help out is by lessening the impact of internal combustion engines. Cars and vehicles create exhausts full of carbon dioxide, nitrogen dioxide, and other pollutants. Using modes of transport like walking, biking or public transport all help in the reduction of air pollution. It is also preferred that people use cars with increased fuel efficiency or electric cars that do not rely on fossil fuels. If people have no choice but to use their private transport then they can take steps to reduce emissions. Keep the engine tuned and the

tires properly inflated to decrease fuel consumption. Many cities are helping by investing in better, affordable public transportation and developing city plans that include infrastructure for walking, biking, and public transit.

To reduce electricity usage people are being asked to turn off electrical appliances when not in use. As most electricity comes from burning fossil fuels, demand for electricity means more pollutants are being pumped into the atmosphere. Other ways to save electricity is to buy appliances rated for energy efficiency and keep the thermostat set higher in the summer and lower in the winter. The last point about people powering their homes is that they are being asked to invest in renewable power sources for their homes. Many countries are already using renewable, nuclear or lower emission power sources for homes to meet their power demand while adhering to their annual pollutant emissions.

People who are vulnerable to pollutants, they are being asked to monitor air quality warnings so that they can take precautions. For people who are not vulnerable, they are also being asked to monitor air quality warnings as that means they know they need to be more mindful of actions that could increase air pollution.

Marylebone Station is the first place in the UK to be fitted with an air filtration system. The filtration system can remove up to 95% of traffic fumes and residual airborne pollutants, according to Airlabs. The idea of these air purifiers is not just to clean the air for people in the train station, but it is also to draw attention to the fact that air quality is only measured outside of train stations and not on the inside where air quality could be at its worst.

As it stands at the moment the only line of defence for pollution from internal combustion engines is catalytic converters. Catalytic converters change harmful substances in a car's exhaust gasses, such as carbon monoxide, nitric oxide, nitrogen dioxide and hydrocarbons, into less harmful substances like carbon dioxide and water vapour by utilizing chemical reactions. They are fitted to the exhaust system of all cars however not all catalytic converters are the same. A simple two-way oxidation cat works to turn carbon monoxide into carbon dioxide and hydrocarbons, which are particles of unburnt fuel, to carbon dioxide and water. More advanced three-way catalytic converters are fitted to modern cars and these do the above while also reducing emissions of nitric oxide and nitrogen dioxide, a major cause of localised air pollution.

When three-way catalytic converters were introduced, there was seen to be a big reduction of pollutants from individual cars. The problem is that catalytic converters are not fully efficient and quite a lot of pollutants still get released into the surrounding area.

Discussion on my research

Starting with the research that I have done on how air pollution can affect peoples health, especially those who have respiratory diseases. When I looked at the data from the World Health Organisation, it was surprising to see just how badly poor air quality can affect people. With over 4.2 million deaths a year related to air pollution, it is a stark reminder that things need to be changed to improve the effects of automotive air pollution. I already had an idea that air pollution could affect those with respiratory diseases, however, I would not have expected to see its effects go as far as contributing towards circulatory diseases, such as heart attacks and strokes.

The news report of Ella that passed away due to poor air quality, was a perfect example of how automotive traffic is one of the major contributors to pollution. As she lived near the South Circular Road in Lewisham, south-east London, one of Londons busiest roads, there was no doubt that most of the air pollution was coming from that road. I strongly believe that this is evidence that the government should be doing more to help reduce traffic in heavily populated areas. One solution I have to fix this is to raise congestion charges for those who do not live in the local area. With current congestion charges, I believe that most people with cars that exceed the emissions to be charged can pay them too easily making congestion zones just a standard route for them.

The research that I have done on the history of air quality shows strong evidence that I was correct about the introduction of the automotive industry declining air quality in densely populated areas. The first major section of research that proves this is that as the automotive industry started to boom there was a massive increase in the amounts of nitrogen dioxide and small particles in the air. This proves that there is a direct correlation between the mass use of automotive transport and the big decrease in air quality from pollutants being exhausted into the air. The second major evidence that proves the automotive industry causes a decline in air quality is that as congestion charges were introduced, air quality started to significantly improve. Therefore, the more vehicles that are in traffic in a condensed area, the more air pollution will

occur. The final major evidence from the historical research was that when the world was in lockdown because of Covid-19, London saw the best air quality since the start of the century. Due to the significant lack of vehicles on the roads and the increase in air quality, I believe that this is the strongest evidence I found that the automotive industry is one of the largest contributors to air pollution.

In response to my research on the current solutions the world is using to reduce pollution, I believe that what we are doing is good and should be welcomed. However in my opinion the solutions will not do enough to achieve world air quality targets. The idea of setting up laws to reduce pollution is a good idea as it gives governments a benchmark to see how well they are performing when it comes to reducing pollution. However, the laws are only an aim and can not reduce pollution alone. Something that I believe would help these laws be more effective is by applying fines to countries that exceed the recommendations set by the World Health Organisations. By applying these fines I believe that governments would be put under more pressure to achieve annual pollution limits.

The second solution of getting people and businesses to reduce the amount of coal-burning is also a good solution as coal is one of the other major factors causing an increase in air pollution. In my opinion, this is one of the best solutions that will have added effect as more vehicles turn to fully electric instead of the internal combustion engine. As the world switches to more renewable ways to produce electricity, this will mean fewer electric cars will be charged up from electricity that comes from coal plants. I think that the future of power, with the technology we currently have, should come from nuclear plants. The reason I think this is that it is one of the cleanest, most efficient and renewable sources of power. I do also believe that solar and wind power could also be an effective substitute for coal power plants, however, I can not see these types of zero-emission, sustainable sources being able to power whole countries without taking up too much agricultural land.

The third solution of getting people to lessen the impact of internal combustion engines is a good solution as it will help reduce air pollution in areas that directly affect peoples health. The use of other modes of transport would be a great way to keep air pollution down as we move towards the electric era of vehicles. The only problem that I think we will face with this is whether or not people will listen to the advice. Some people get attached to driving cars and so

they would not be willing to sacrifice walking or cycling for transport. One way to get more people to be on board with this solution would be to give the people that switch driving for other transport modes benefits.

The fourth solution of people being asked to turn off electrical appliances when not in use is another great way to reduce air pollution as most electricity comes from burning fossil fuels and demand for electricity means more pollutants are going into the air. This along with getting people to invest in more energy-efficient appliances would be an easy fix for reducing electricity demand. The only problem that I can see with this solution is whether people will be non-compliant as to some people having devices like televisions on standby is good enough to save power.

The solution of people being asked to monitor air quality warnings so that they can take precautions is a good one to help reduce the effects on people's health. Though this does not directly reduce air pollution, it is still something that should be done with air quality being so poor in today's world to reduce people falling ill from adverse health effects.

I think the solution at Marylebone Station of introducing air purifiers into areas that may have the worst air purity is good for immediate improvements. The way how I see this solution is it is like a second line of defence after catalytic converters on vehicles. With the implementation of more of these, the air pollution in densely populated areas could potentially be at a more acceptable level.

With my research on catalytic converters, I think that a good solution would be to improve on the three-way exhaust. As these are currently the only line of defence for pollutants from modern-day vehicles, these should be made more effective because this would then significantly reduce toxic emissions. Even though we are coming to the end of the use of internal combustion engines, air pollution is not something we can wait on.

Solution

During my time researching this question of 'what are the effects of automotive air pollution in densely populated areas?', I have realised that there are not many solutions that cause an

instant decrease in air pollution. The only solution that does this is the air purifier in Marylebone Station. I have an idea to advance on the design of this and make the principal of this mobile. If this idea was turned autonomous, then it would cause immediate improvements in air quality where it is needed. It would be a slightly larger scale air purifier with a modular design. The modular design would allow this purifier to transport its self in a way that best suits its environment. In one of its modular modes, it could be used on overhead rails. This would be a good mode for areas with high traffic flow as it would not disturb the traffic flow and cause congestion, which is a contributor to air pollution. In its alternative mode, it could be used as a fully autonomous car. This would be suited in areas of low traffic and in areas where overhead transport is unavailable. This would mean that its suited environment would probably be in areas that are local to coal power plants and industrial parks. While this air purifier may not be able to reduce Ozone pollution, it will offer an excellent way of removing particle matter PM10 and PM2.5. With the addition of the catalyst used in a catalytic converter, it will also be able to remove a large number of toxic gas pollutants such as nitrogen dioxide. To make sure that the air purifier does not make any contributions to the production of pollutants, it would only be run on electricity that will have only come from sustainable sources that do not exhaust any pollutants. With it being fully autonomous, it could work in a network of other mobile air purifiers so that they will know the best place to be in the area to keep the pollutant levels down.

Conclusion

In response to the main research question, many effects are caused by the automotive industry to do with air pollution. The biggest effect that surprised me was the health effects of air pollution. I did not expect the number of deaths worldwide to be so high from the contributions of air pollution. I believe that as we start to introduce more efficient technologies into the automotive industry, the effects that are caused by transport will diminish. Until the point where this happens, we need to find the best solutions to decrease air pollution otherwise we could be waiting decades for improvements to be made. As my research makes clear, waiting simply is not an option as too many people are dying annually because of this. The solutions that we have are good to help tackle this escalating problem, but I do not believe they are good enough. I have found that with some rectifications, these solutions could be made more effective and air pollution would see a sharper decline. However, these rectifications could only do so much.

As I believe that the worst effect of automotive air pollution is health effects, I believe that the solution I have thought of would be perfect as it should in theory have an immediate effect on local air purity and therefore reduce the effects it has on people vulnerable to air pollution. I think that if there were to be more solutions like mine to be implemented in densely populated areas then there would be a significant drop in premature deaths per year.

As a final reflection, I think that I have done a good job at achieving my aim of highlighting the causes of automotive air pollution in densely populated areas to bring awareness to the automotive industry. I provided a good argument in response to the question with viable and factual research. I also think that me writing this will make me more conscious of the decisions I make in my practice as an automotive designer. I do not just think it will make me think about the impact my designs may have on air pollution, but I also believe it will make me think about all of the impacts that they may have on everyone worldwide. Having this ability will make me a better automotive designer as it will make me realise why I am designing each specific vehicle.

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