iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** XI **Month of publication:** November 2021

DOI: https://doi.org/10.22214/ijraset.2021.39121

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue XI Nov 2021- Available at www.ijraset.com

Environmental Aspects of Toll Plazas & Vehicular Pollution

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Abstract: ***The study aims to encapsulate the effects of toll plazas on environment. It is intended to outline various environmental aspects that are of serious concern and should be looked upon necessarily to curtail their long term ill effects on environment and humans. The rapid development in urban India has resulted in a tremendous increase in the number of motor vehicles. Air pollution is a serious environmental health threat to humans. Adverse effects range from nausea, difficulty in breathing and skin irritations, birth defects, immunosuppression and cancer. Air pollution, particularly in the form of particulate matter, is a serious challenge in India, and transportation is a significant factor in the nation's air quality problems. According to the 2017 Global Burden of Disease, some 1.1 million people in India die prematurely each year from diseases directly related to air pollution, making it the fifth leading cause of death in the country. Transportation sources account for approximately a third of PM pollution in India, and a somewhat higher proportion of nitrogen oxides, another set of compounds harmful to human health. Because its vehicle fleet is small relative to its large population, India has very low per capita transportation emissions. But that fleet is growing rapidly: total vehicle sales (including motorcycles) increased from about 10 million in 2007 to over 21 million in 2016, and the total number of vehicles on the road is expected to nearly double to about 200 million by 2030.***

All these situations indicate that air pollution becoming a major problem in Indian context and there is an essential need to build up healthy environment and increase the level of research around the world.

The study is based on the case study results from one of the toll plaza's (KACHKOOT TOLL PLAZA) in j&k,India ..

Keywords: (Air pollution, Vehicular emission, Carcinogenicity ,Air Quality Index, Toll, Diseases)

I. INTRODUCTION

India is a country with the second largest road network in the world. Out of the total stretch of 5.4 million km of road network, almost 97,991 km is covered by national highways. The National Highways Authority of India (NHAI), a nodal agency of the Ministry of Road Transport and Highways is responsible for the maintenance and the expansion of the highways. Travelling on these state/national highways also known as toll roads requires a tax to be paid called the Toll Tax. The government spends the taxes collected by means of toll roads usage on the maintenance of these roads so that the drivers and the riders can travel comfortably.

These limitations in the conventional toll collection systems called for an immediate revamp in the Indian toll collection machinery. Thus, a step in this direction was taken by National Highways Authority of India (NHAI), a nodal agency of the Ministry of Road Transport and Highways by introducing "FASTag" which employs Radio Frequency Identification (RFID) technology and provides for seamless movement of FASTag affixed vehicles at toll plazas.

With the rapid growth in population, scarcity of natural resources and environmental degradation have emerged as serious concerns globally. Researchers are putting effort to identify all possible ways to limit the wastage of natural resources and control of environmental pollution. A significant source of natural resource consumption and pollution in the present world is transportation. In developing countries like India, significant growth of air pollution has been observed due to the growing rate of vehicle transportation (Jason, 2015). Concerns with the transport segment are not limited to air pollution only. The transport segment also offers several other issues related to noise pollution, traffic congestion, augmented travel timings, and natural resources such as fossil fuel consumption. These issues have compelled researchers to find innovative solutions to optimize transportation systems in terms of minimum vehicular pollution, economic feasibility, and operability. Particularly, the road transportation accounts for a major share of fuel consumption as well as pollution emission (Jiménez-Uribe et al.,2020). With more vehicles adding up every year in the road system, a rapid rise in fuel economy can be observed. Road transportation is also liable for environmental and health problems in the urban and rural areas linked with the roadways. Prolonged exposure to common vehicular pollutants can lead to various respirational and cardiovascular issues.

II. LITERATURE REVIEW

In developing countries like India, significant growth of air pollution has been observed due to the growing rate of vehicle transportation (Jason, 2015). Concerns with the transport segment are not limited to air pollution only. The transport segment also offers several other issues related to noise pollution, traffic congestion, augmented travel timings, and natural resources such as fossil fuel consumption. These issues have compelled researchers to find innovative solutions to optimize transportation systems in terms of minimum vehicular pollution, economic feasibility, and operability. Particularly, the road transportation accounts for a major share of fuel consumption as well as pollution emission (Jiménez-Uribe et al., 2020). With more vehicles adding up every year in the road system, a rapid rise in fuel economy can be observed. Road transportation is also liable for environmental and health problems in the urban and rural areas linked with the roadways. Prolonged exposure to common vehicular pollutants like PM10 and PM2.5 can lead to various respirational and cardiovascular issues. On an estimate, particulate matter particle pollution caused 620000 non-natural deaths in India in the year 2010 itself (Surendra,2016). Another form of pollution that comes with vehicular emissions is noise pollution, and facts show that noise pollution due to traffic is also a severe concern posing adverse environmental and health effects (Espinoza-Arias et al., 2019; Singh et al., 2020). The excessive traffic on urban roads in cities and highways causes sound pollution, which is triggering hearing ailments in regular traffic commuters.

Before you begin to The growing cities, increasing traffic, trajectory growth, rapid economic development and industrialization with higher levels of energy consumption have resulted in an increase in pollution load in an urban environment (CPCB, 2010). Air pollution is the major environmental risk to health and is estimated to cause approximately 2 million premature deaths worldwide per year (WHO, 2005). Besides health effect, air pollution also contributes to tremendous economic losses, especially in the sense of financial resources that are required for giving medical assistance to the affected people.

In India, the vehicle population is growing at the rate of over 5% per annum and today the vehicle population is approximately 40 million. The vehicle mix is also unique to India in that there is a very high proportion of two-wheelers are 76% (SIAM, 2011). The growth rate of vehicles is the backbone of economic development and the Indian automotive industry (the second fastest growing in the world). Today, in the country about 7-8 million vehicles are produced annually. In 2011, the country reported 141.8 million registered motor vehicles The Road transport sector accounts for a share of 4.8% in India's GDP (MORTH, 2011). In India, the number of motor vehicles has grown from 72.7 million in 2004 to approximately 141.8 million in 2011, of which two-wheelers (mainly driven by two-stroke engines) accounts for approximately 72% of the total vehicular population .There is a direct relationship between road transport system and air pollution in a city. Vehicular emissions depend on vehicle speed, age of vehicle and emission rate

In general, the average peak hour speed in Indian cities isfar less than the optimal one. Growing traffic and limited road space have reduced peak-hour speeds to 5-10 Km/h in the central areas of many major cities. We must retain that the estimation of road transport pollutant emission should allow significant disaggregation of the result by fuel type and composition, by vehicle type, by emission standard. In general, one differentiates also emission produces in and out of the city, and also time scale can be necessary, depending on the objectives of the environmental assessment (Shrivastav et al., 2013).

Numbers of vehicles sold in India are increasing at a rapid rate. In 2005-06, there were 8.9 million vehicles sold and in five years this number has scaled to 15 million (in 2010-11). While accelerated growth in the number of vehicles aids growth and development, the problem stems from their concentration in a few selected cities. It is alarming to note that 32% of these

vehicles are plying in metropolitan cities alone, which constitute about 11% of the total population. Delhi, which contains 1.4% of the Indian population, accounts for nearly 7% of all motor vehicles in India. Two-wheelers and cars account for more than 80% of the vehicle population in large cities.

Air pollution is one of the serious environmental concerns of the urban cities where majority of the population is exposed to poor air quality. The rapid urbanization in India has resulted in a tremendous increase in the number of motor vehicles. As the number of vehicles continues to grow and the consequent congestion increases, vehicles are now becoming the main source of air pollution in urban India. The country has taken a number of measures for the improvement of the air quality in cities. These include, the improvement in the fuel quality, formulation of necessary legislation and enforcement of vehicle emission standards, improved traffic planning and management, etc

Globally the transport sector is responsible for 25% of total carbon dioxide (CO_2) emissions from fuel combustion in 2018 (IEA, 2020). It is the fastest growing sector and is a major contributor of global greenhouse gas emissions (Hasan et al. 2019). In India, it is the third most CO_2 emitting sector, and within the transport sector, road transport contributed more than 90% of total CO_2 emissions (IEA, 2020; Ministry of Environment Forest and Climate Change, 2018). The greenhouse gas (GHG) emissions in India consisted of 70% CO_2 and 30% non-CO_2 (methane, nitrous oxide, F-gas) emissions (Olivier and Peters 2020).

With economic development in India, the vehicle ownership level has increased with a growth rate of 10.4% for two-wheelers and 11% for cars from 2001 to 2015 (Singh et al. 2020), leading to an increase in emission levels on the road. An increase in vehicle population also contributed significantly to India's air pollution (Guttikunda & Kopakka, 2014). Serious health issues are observed due to high exposure to air pollution (PM and NOx) in India (Guttikunda et al. 2015). Hence, various transport policies were introduced in the past, which impacted the vehicle exhaust emission and influenced the characteristics of the vehicles present in the fleet and their activity levels. Vehicle population with fleet configuration and their activity profile have been significantly affected by the transport policies (Nesamani 2010; Zhang et al. 2014).

Automotive vehicles emit several pollutants depending upon the quality of the fuel they consume and engine efficiency. The release of pollutants from vehicles also include fugitive emissions of the fuel and the source and level of these emissions depending upon the vehicle type, its maintenance, etc. The major pollutants released as vehicle/fuel emissions are, carbon monoxide (CO), nitrogen oxides (NOx), photochemical oxidants, air toxics, namely benzene (C6H6), aldehydes, 1,3 butadiene (C4H6), lead (Pb), particulate matter (PM), hydrocarbon (HC), oxides of sulphur (SO2) and polycyclic aromatic hydrocarbons (PAHs). While the predominant pollutants in petrol/gasoline driven vehicles are hydrocarbons and carbon monoxide, the predominant pollutants from the diesel based vehicles are Oxides of nitrogen and particulates.

The transport demand in India has been growing rapidly. Sustained economic growth, improved road infrastructure and increased disposable income of households have led to the rising demand for road transport. There has been a continuous increase in the number of registered motor vehicles in India since 1951. The total number of registered motor vehicles increased from about 0.3 million in March, 1951 to 230.03 million up to 31st March, 2016 . The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 9.9 per cent between 2006 and 2016.

Table 20.1-NUMBER OF MOTOR VEHICLES REGISTERED IN INDIA
(TRANSPORT AND NON TRANSPORT as on 31st March)

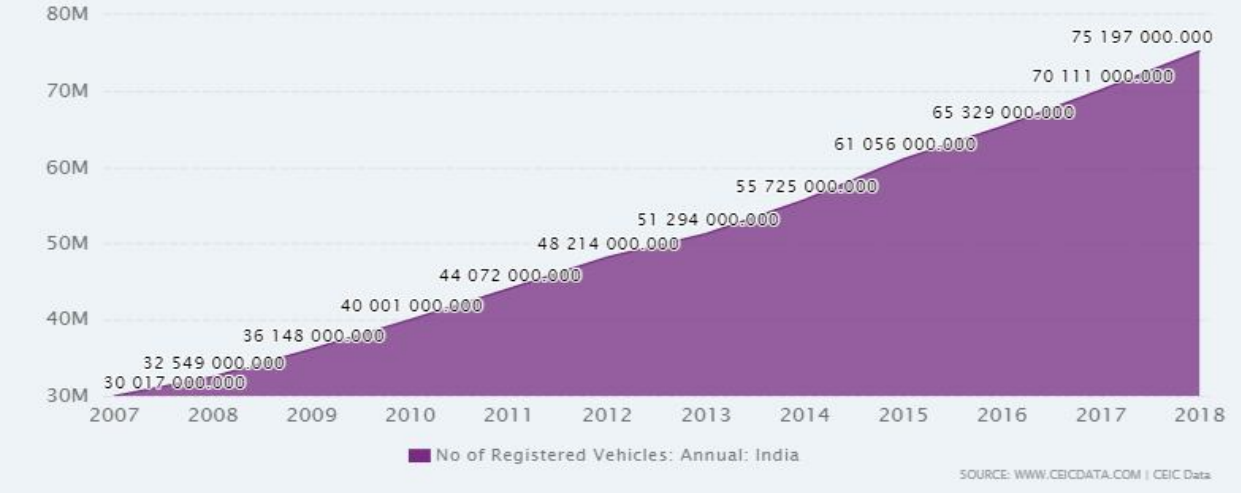
Year	Buses	Taxis	Light Motor Vehicles(Passengers)	Goods vehicles(a)	Two-wheelers	Cars	Jeeps	Miscellaneous(b)	Grand Total
1	2	3	4	5	6	7	8	9	10
2001	633900(b)	634357	1777130	2948300	38556026	5297219	1126148	4017946	**54991026**
2002	635006	688204	1878261	2973740	41581058	5748036	1177245	4242787	**58924337**
2003	720696	825416	2113781	3491637	47519489	6594166	1180057	4562042	**67007284**
2004	767593	901889	2167324	3748484	51921973	7267174	1282113	4661385	**72717935**
2005	678521	939738	2337264	3877622	58799702	8072650	1307926	5488296	**81501719**
2006	762341	1039845	2492726	4274984	64743126	9109855	1376744	5818646	**89618267**
2007	1098422	1042347	2697449	5118880	69128762	10146468	1460364	6014568	**96707260**
2008	1156568	1201862	2903821	5600938	75336026	11200142	1547825	6405672	**105353854**
2009	1205793	1307805	3146619	6040924	82402105	12365806	1638975	6843006	**114951033**
2010	176642	3615086	3615086	6431926	91597791	13749406	1760428	7552876	**127745972**
2011	1238245	1789417	4016888	7064495	101864582	15467473	1974253	8045441	**141865607**
2012	1296764	2011022	4242968	7658391	115419175	17569546	1987098	8866332	**159490578**
2013	1418763	2216453	4718672	8596762	132550294	20503389	2132893	9768046	**182445229**
2014	1468010	2109348	4638377	8697541	139409778	21671515	2216888	9778764	**190703971**
2015	1527396	2256619	5028312	9344464	154297746	23807986	2546731	10474886	**210023289**
2016	1384740	2341375	6392010	10516156	168975300	25634824	2265488	12048062	**230030598**

Source: Transport Research Wing, Ministry of Surface Transport

(a)Also include multi axled/Articulated Vehicles/Trucks and Lorries and light motor vehicles

(b) Includes Omni buses/Tractors/Trailors/Others.

Number Of Motor Vehicles Registered In India (Taxed And Tax-Exempted)



III. ENVIRONMENTAL ASPECTS OF TOLL PLAZAS

According to government data from March 2020, India has a total of 566 toll plazas where toll is collected. As several researches have been conducted all over the country on these toll plazas ,about the time wastage, fuel wastage and pollution caused due to the heavy traffic rush at those toll plazas.

As calculated from the case study at " KACHKOOT TOLL PLAZA" , near about 53655 litres were wasted at a single toll plaza in case of automated electronic toll collection system and 109500 litres were wasted in case of manual toll collection system per year.

1 liter of diesel weighs 835 grams. Diesel consist for 86,2% of carbon, or 720 grams of carbon per liter diesel. In order to combust this carbon to CO_2, 1920 grams of oxygen is needed. The sum is then 720 + 1920 = 2640 grams of CO_2/liter diesel. An average consumption of 5 liters/100 km then corresponds to 5 l x 2640 g/l / 100 (per km) = 132 g CO_2/km.

1 liter of petrol weighs 750 grams. Petrol consists for 87% of carbon, or 652 grams of carbon per liter of petrol. In order to combust this carbon to CO_2, 1740 grams of oxygen is needed. The sum is then 652 + 1740 = 2392 grams of CO_2/liter of petrol. An average consumption of 5 litres/100 km then corresponds to 5 l x 2392 g/l / 100 (per km) = 120 g CO_2/km.

So roughly taking various studies also into consideration 2.3 kg of carbon dioxide are emitted per litre of fuel. Hence total amount of CO_2 emitted at toll plaza =

$=2.3 \times 53655=123406$ kg in case of Electronic toll collection

& $=2.3 \times 109500=251850$ kg in case of manual toll collection

From the above calculations we can estimate how much CO_2 is emitted all over india at about 566 toll plazas yearly

Diesel exhaust composition

	Average Diesel engine exhaust composition (Reif 2014)[17]	Average Diesel engine exhaust composition (Merker, Teichmann, 2014)[18]	Diesel's first engine exhaust composition (Hartenstein, 1895)[19]	Diesel engine exhaust composition (Khair, Majewski, 2006)[20]	Diesel engine exhaust composition (various sources)
Species	Mass percentage	Volume percentage	Volume percentage	(Volume?) percentage	
Nitrogen (N_2)	75.2%	72.1%	-	~67 %	-
Oxygen (O_2)	15%	0.7%	0.5%	~9 %	-
Carbon dioxide (CO_2)	7.1%	12.3%	12.5%	~12 %	-
Water (H_2O)	2.6%	13.8%	-	~11 %	-
Carbon monoxide (CO)	0.043%	0.09%	0.1%	-	100–500 ppm[21]
Nitrogen oxide (NO_x)	0.034%	0.13%	-	-	50–1000 ppm[22]
Hydrocarbons (HC)	0.005%	0.09%	-	-	-
Aldehyde	0.001%	n/a			
Particulate matter (sulfate + solid substances)	0.008%	0.0008%	-	-	1–30 $mg \cdot m^{-3}$[23]

Composition of diesel exhaust (source wikipedia)

Pollutant	Effect on Human Health
Carbon Monoxide	Affects the cardio vascular system, exacerbating cardiovascular disease symptoms, particularly angina; may also particularly affect fetuses, sick, anemic and young children, affects nervous system impairing physical coordination, vision and judgments, creating nausea and headaches, reducing productivity and increasing personal discomfort.
Nitrogen Oxides	Increased susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
Sulphur Dioxide	Affect lung function adversely.
Particulate Matter and Respirable Particulate Matter (SPM and RPM)	Fine particulate matter may be toxic in itself or may carry toxic (including carcinogenic) trace substance, and can alter the immune system. Fine particulates penetrate deep into the respiratory system irritating lung tissue and causing long-term disorders.
Lead	Impairs liver and kidney, causes brain damage in children resulting in lower I.Q., hyperactivity and reduced ability to concentrate.
Benzene	Both toxic and carcinogenic. Excessive incidence of leukemia (blood cancer) in high exposure areas.
Hydrocarbons	Potential to cause cancer

Despite air pollution, noise pollution is also one of the serious concern at toll plazas. Noise is something unwanted, unpleasant sound that causes discomfort for all living beings. Noise pollution was brought under air prevention and control pollution act 1981 by amending the same in 1987.Generally the 80 Db and more than that is noise. The main source of noise at toll plaza is vehicular traffic. The amplification of the sound waves due to the toll plaza structures due to reverberation adds in it.Hence efforts need to be taken to reduce these effects on environment and humans.

IV. CONCLUSION

As we know toll tax is important from the economic considerations for the development and maintenance of Highways and roads especially for a developing country like India. But at the same time we need to take steps and find some more efficient ways of road toll tax collection to save our environment from further degradation due to pollution.

Air pollution in India is a serious health issue. Of the 30 most polluted cities in the world, 21 were in India in 2019. As per a study based on 2016 data, at least 140 million people in India breathe air that is 10 times or more over the WHO safe limit and 13 of the world's 20 cities with the highest annual levels of air pollution are in India. 51% of the pollution is caused by industrial pollution, 27 % by vehicles, 17% by crop burning and 5% by other sources. Air pollution contributes to the premature deaths of 2 million Indians every year. Emissions come from vehicles and industry, whereas in rural areas, much of the pollution stems from biomass burning for cooking and keeping warm. India has a low per capita emissions of greenhouse gases but the country as a whole is the third largest greenhouse gas producer after China and the United States. A 2013 study on non-smokers has found that Indians have 30% weaker lung function than Europeans.

The Air (Prevention and Control of Pollution) Act was passed in 1981 to regulate air pollution but has failed to reduce pollution because of poor enforcement of the rules.

In 2015, Government of India, together with IIT Kanpur launched the National Air Quality Index. In 2019, India launched 'The National Clean Air Programme' with tentative national target of 20%-30% reduction in PM2.5 and PM10 concentrations by 2024, considering 2017 as the base year for comparison. It will be rolled out in 102 cities that are considered to have air quality worse than the National Ambient Air Quality Standards.

There are other initiatives such as a 1,600-kilometre-long and 5-kilometre-wide The Great Green Wall of Aravalli green ecological corridor along Aravalli range from Gujarat to Delhi which will also connect to Shivalik hill range with planting of 1.35 billion (135 crore) new native trees over 10 years to combat the pollution. In December 2019, IIT Bombay, in partnership with the McKelvey School of Engineering of Washington University in St. Louis, launched the Aerosol and Air Quality Research Facility to study air pollution in India According to a Lancet study, nearly 16.7 lakh deaths and an estimated loss of USD 28.8 billion worth of output were India's prices for worsening air pollution in 2019.

Due to huge amount of traffic there is a greater amount of both air pollution as well as noise pollution at the toll plaza's. Vehicular pollution contributes a major part of overall air pollution. The main pollutants emitted from automobiles are hydrocarbons, lead/benzene, carbon monoxide, Sulphur dioxide, nitrogen dioxide and particulate matter. Majority of the emission gases are harmful to humans & may cause several diseases in the personals who have prolonged exposure to them.

Air pollution imposes a cost on society as it increases both morbidity and mortality. There is thus an urgent need to deal with the problem of vehicular pollution. Advanced emission norms, Bharat IV and VI are being adopted to deal with the problem. Awareness has to be created among people to undertake measures to keep their vehicles well maintained to reduce emissions. However, the greatest benefit come from the public transport as it will reduce the number of vehicles on Indian city roads at the same time meeting the mobility needs of the people. The pollution level can be minimized by the use of innovative and technical methods as well as the alternative fuels. Measures should be taken to run public transport vehicles on fuels which pollute less such as Compressed Natural Gas, so that emissions from these vehicles can be minimized.

Therefore, it is recommended that effective vehicle emission control strategies should be developed and implemented. Vehicle maintenance and inspection program should be developed to ensure the effectiveness of the vehicle emissions-control systems.

Proper maintenance, inspection, clean car, use of clean fuel is the ways to reduce emissions.

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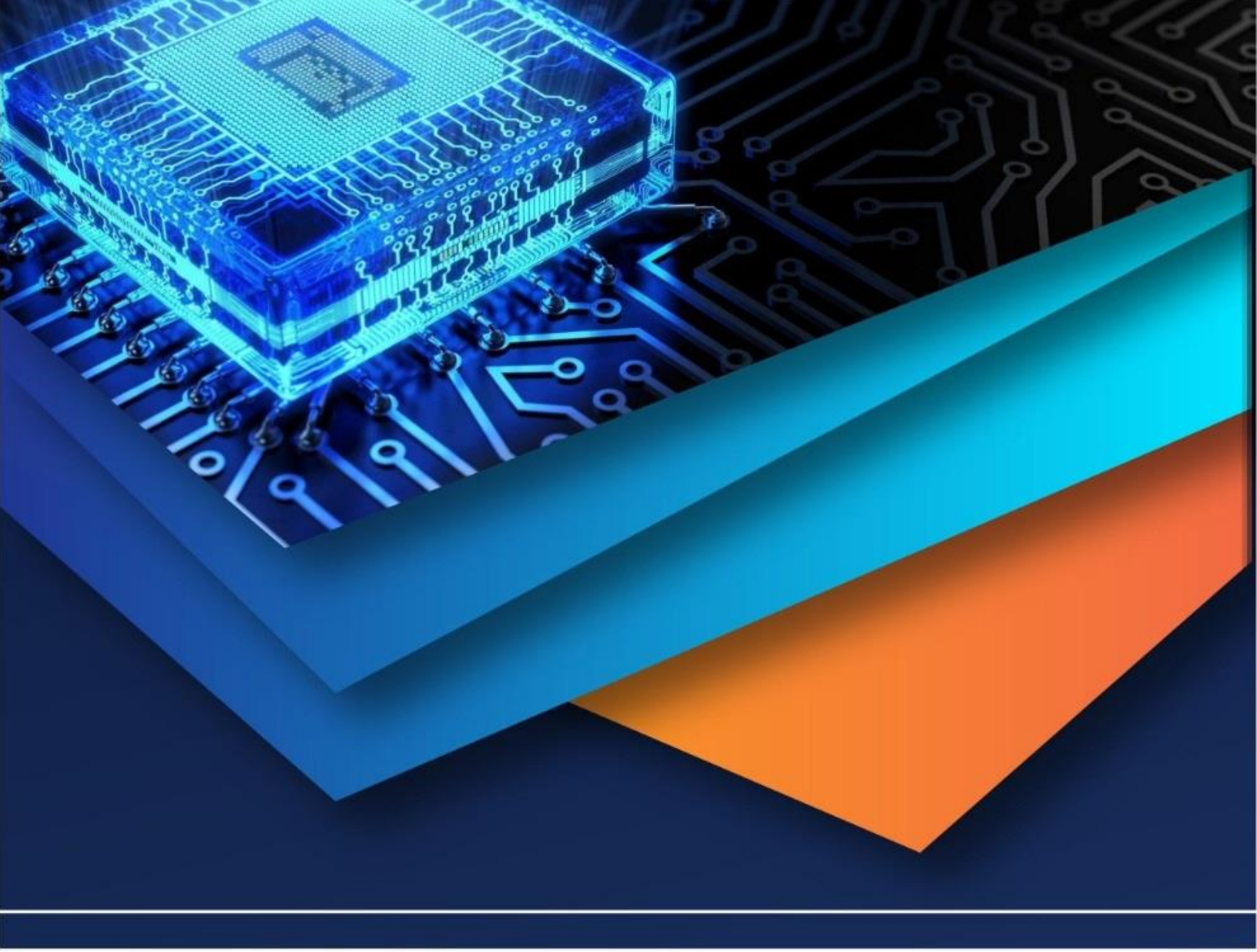

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