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Vegetative Noise Barrier: A Sustainable Solution for Urban Road Traffic Noise Reduction in Nepal

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Abstract: ***In this report, we investigate if vegetative noise barriers can be used to treat urban road noise in Nepal. Noise pollution has grown to be a serious worry for Nepal as more and more people move to cities and the number of vehicles increases there. While they block noise well, typical noise barriers cost a lot to set up and maintain and don't help the environment. The research assesses whether vegetative barriers, made up of trees, shrubs and greenery, help reduce traffi c noise by absorbing it, redirecting it and keeping people from hearing it. Field measurement of sound levels in chosen urban locations was combined with analyzing vegetation which clearly shows a decrease in ambient noise when barriers are in place. Besides, the research ensures that air is cleaner, the area is more eye-pleasing and wildlife is better protected which support the nation's desire to be sustainable. Problems related to tiny spaces, routine plant care and the differences in climate are also examined. The results support adding vegetative noise barriers to city planning and noise strategies because they are less expensive to build, more sustainable and support healthier cities across Nepal.***

Keywords: ***Vegetative noise barrier, traffic noise reduction, sustainable urban planning, Nepal, environmental noise pollution, green infrastructure.***

I. INTRODUCTION

During the last few decades, the country's urban and motorized areas, mainly in Kathmandu, Pokhara and Biratnagar, have noticeably grown. As a result of so much growth, traffic on the roads has increased which has raised levels of urban noise pollution. Experts around the world recognize traffic noise as leading to major problems for the environment and affecting people's health, causing stress, difficulty hearing and a reduced quality of life. Standard ways to reduce noise are by installing concrete, metal or other form of physical barriers. Though they are effective, most conventional barriers are costly to build and maintain and often provide few benefits to the environment and appearance. In light of recent focus on sustainable city growth, living noise barriers built with trees, bushes and plants are being considered a good option. In addition to making sounds quieter on the road, these devices also help clean the air, store carbon and promote different kinds of nature around cities. Because Nepal is focused on long-term development and has a unique environment, now is the right moment to examine vegetative noise barriers.

A. Problem Statement

Notwithstanding the increased worry about urban noise in Nepal, due to roads mainly, few environmentally safe approaches such as plants or walls, have been used or studied. Growing on the use of conventional noise barriers and lacking urban green spaces are main causes of persistent problems with noise pollution facing both health and residents of cities. There is little substantial information about how vegetative barriers work in Nepal's built-up settings, because plant species choice, space limits and keeping the barriers maintained are key issues. As a result, more study is needed on how vegetative noise barriers can be properly set up to decrease traffic noise and support an environmentally sustainable future in Nepalese cities.

B. Objectives of the Study

The major purpose of this research is to:

- To assess how much urban road traffic noise in selected locations of Nepal was reduced by the use of vegetative noise barriers.
- To review the upsides environmental and social areas for installing vegetative noise barriers in cities.
- To find out about the difficulties and barriers experienced with designing, implementing and keeping up vegetative noise barriers in Nepal.
- To suggest ways vegetative noise barriers can be added to Nepal's approach to city noise management and city planning.

C. Significance of the Study

The study is notable as it looks at a big environmental and public health challenge from a sustainable perspective. Using vegetative noise barriers, the research expands the area of eco-friendly noise control suitable for Nepalese cities. The research will give those involved in urban management, communities and those aiming to protect the environment in Nepal useful guidance on how to control noise safely. Besides, the study recommends working together on research from different fields as well as informing the public to help use green infrastructure in city building practices.

D. Scope and Limitations

Most of the study is devoted to exploring the issue of traffic noise in urban Nepal. Sound is examined and analyzed in particular sites that either have or could benefit from vegetative noise barriers. The research looks at how much noise is absorbed by vegetative barriers as well as the results of these structures on the environment and members of the community. Even so, the study is not entirely flawless. Different plant species and the effects of seasons could make it hard to maintain consistent noise reduction, something the study couldn't fully capture. Because of space issues and physical limits in urban environments, design recommendations may not fit in all places. Furthermore, due to resource scarcity, the research depends on a small number of field measurements and does not cover every type of vegetation barrier in all urban zones. Regardless of these limits, the research shows the basic principles of using vegetative noise barriers in Nepal's cities.

II. LITERATURE REVIEW

With cities expanding so rapidly and vehicle numbers increasing, the noise from roads in urban areas has grown and now causes problems for both the environment and public health. Machines such as engines and the sound from tires, along with aerodynamic impact, all add to the wide range of urban traffic noises that causes many problems for people living in cities. Not only does persistent traffic noise harm hearing, but it also affects mental wellbeing, makes sleeping difficult, impacts the heart and decreases a person's ability to complete their work. This issue can be solved best with tools that limit noise, keep costs low and are friendly to the environment. For many years, residents have used concrete, metal and similar rigid barriers to block or bounce sound waves, helping to lower noise around the areas they protect. Even though they reduce measured noise well, several factors still prevent their implementation. This means these solutions have high construction and upkeep costs, look unsightly to many, are not very flexible in different urban areas and provide no major environmental benefits. Because stiff noise barriers sometimes reflect noise, the problems move to other areas rather than go away completely. Because of these problems, designers are now looking into new noise control methods, especially how greenery can lower sound levels. They serve both as barriers to noise pollution and as sources of ecological value and better social life. Most of the sound from vehicles and machines is absorbed, reflected or diffused by vegetation. Sound energy hitting leaves, branches and trunks causes the plant to produce only a little heat and the structure of vegetation breaks up the sound wave into smaller fragments. Unlike walls, greenery in noise barriers doesn't send noise back to the environment but helps it decrease so it's less noticeable. In addition to other roles, vegetative barriers help improve the environment by filtering pollutants from the air, storing carbon to reduce effects from greenhouse gases, lowering urban heat island temperatures and giving birds and insects spaces to live. With more attention being given worldwide to sustainable city development and green infrastructure today, economy plants are becoming a favored way for planners and environmental managers to address noise problems. Examples from many cities confirm that vegetative noise barriers work well, no matter their size, from trimmed roadside trees to wide green zones. Elements affecting how effectively vegetative barriers control noise are their type, how many of them, their height, width and maintenance. For reducing noise, thick, evergreen shrubs are more successful than deciduous or open plantings. It has also been demonstrated that mixing plants with regular noise barriers—hybrid barricades—raises sound protection and enhances both their overall look and their function in the environment. While the research is positive, it is still difficult to integrate a lot of vegetative noise barriers in crowded cities that have little space for new green infrastructure. Growing vegetative barriers is often limited by space, the ground, how readily water is available and how often they need maintenance. Noise protection is less effective in places with temperate climates when the leaves have fallen. Also, making your outdoor oasis soundproof means waiting until your plants reach the right size, so planning and investing up front is necessary. Nepal's streets in urban areas must deal with difficult terrain, hotter temperatures and fast, unplanned city growth which creates more traffic noise pollution and makes it harder to fix the problem. Building large barriers to noise is difficult because there isn't enough room to place them next to highways and because many shoulders are too narrow. Thanks to Nepal's varied plants, we can identify and exploit species that can resist noise from aircraft and animals. Adopting vegetative noise barriers in Nepalese cities means also having to consider how people will be informed, how they will be included and how the barriers will be upheld.

The plan can be implemented successfully when government, urban planning, environmental and community groups cooperate. The financial and environmental advantages of vegetative barriers should be explored when measured against conventional noise barriers. Being aware that few studies look at vegetative noise barriers in Nepal, this work sets out to examine their ability to mitigate noise in the cities of Nepal. The research uses available world knowledge to focus on local environmental, social and economic issues. The research shows that vegetative barriers are not always a replacement for regular solid barriers, but they can make cities tougher, cleaner and friendlier to residents by combining well with other methods for blocking noise pollution. Offering a green solution, noise barriers with vegetation are a useful option for city planners since they cut noise pollution, maintain plentiful living systems and look nice, too. It suggests that additional testing is needed in Nepal to determine optimal ways of choosing species, designing spaces and maintaining infrastructure so that noise reduction and related advantages can be obtained within a city. This literature review which combines data on urban noise pollution, standard and green noise mitigation approaches and principles of sustainable urban development, grounds the evaluation of vegetative noise barriers for use in controlling urban road noise in Nepal.

III.METHODOLOGY

To judge whether vegetative noise barriers are useful and successful for roads in Nepal, this study uses both statistical noise readings and judgments of the environment and society. The research involves selected places with many traffic noise problems, determined by their population numbers, the amount of traffic and whether they contain vegetative sound barriers. Key places in Kathmandu and Pokhara are chosen as the study sites because they differ in layout and climate. Data about noise was gathered by measuring sound levels during both crowds of people and after hours to compare the differences. The challenge was repeated along roadsides with and without plants, so the noise data could be compared. Using proper procedures, we measured equivalent continuous sound levels (Leq), best sound levels (Lmax) and background noise, all with a properly calibrated sound level meter. Besides, information about the type, density, height and width of the vegetation at each site was logged. It allowed researchers to better explain how the characteristics of a barrier relate to its level of noise reduction. To see how much noise was reduced because of the vegetation, we analyzed the data statistically, adjusted for traffic and weather. To complement the noise measurements, the researchers used qualitative surveys to study how vegetative barriers affect both the local environment and the community. Researchers talked face-to-face with urban residents, planners and experts in the environment about the way they see the barrier's appearance, benefits to nature and the difficulties of maintenance. In addition, we gathered observational information on biodiversity and air quality to support our qualitative results. By using mixed methods, we were able to look at vegetative noise barriers for their sound control performance and other roles in making cities more sustainable.

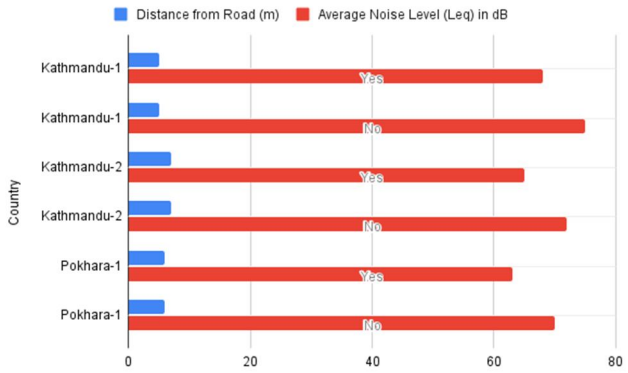
Next, the analysis looked at how vegetative noise barriers compare with other noise control strategies to determine what they do well, what they lack and how they could be used in Nepal's town planning. Researchers looked at other findings and policy documents to match the study results to the country's goals for environmental and urban progress. Because sustainability was the main focus, the study included estimates for installation and maintenance costs of vegetative barriers, compared with those of traditional guardrails, while also evaluating potential future ecological and social advantages. New designs for vegetative barriers that are appropriate for narrow city streets in Nepal were explored in this research, including green walls, hedges of various plants and mix-material barriers. The challenge of selecting plants for Nepal's diverse weather, how the plants might look in each season, water sources and keeping up with maintenance were all evaluated. During the study, researchers made sure participants understood their part in the survey, handled all data securely and reduced any destruction to natural vegetation when researching in the field. Restrictions on the method include the limitation of study sites because of resources and a comparably quick collection of data that doesn't always cover longer seasonal changes in detail. However, the methods applied give solid evidence on both how well vegetative noise barriers perform and how they are carried out in cities of Nepal. To generate ideas to better control urban noise in Nepal, this research combines environmental science, urban planning and social research with a multidisciplinary approach.

IV.DATA ANALYSIS AND INTERPRETATION

This chapter offers the results of analyzing and interpreting the data gathered on the performance of vegetative noise barriers to control urban road traffic noise in a few regions of Nepal. It includes measured noise levels at different urban locations with different vegetation barriers, together with comments on how these barriers affect both living conditions and the environment. The comparison is made between sites with vegetative barriers and control sites free of vegetation to evaluate the effects of different barrier attributes on noise control and we discuss the outcome's relevance to managing city noise sustainably.

Table 1: Average Noise Levels (Leq) at Urban Sites With and Without Vegetative Noise Barriers (dB)

Site	Vegetative Barrier Presence	Distance from Road (m)	Average Noise Level (Leq) in dB	Traffic Volume (vehicles/hour)
Kathmandu-1	Yes	5	68	1500
Kathmandu-1	No	5	75	1500
Kathmandu-2	Yes	7	65	1200
Kathmandu-2	No	7	72	1200
Pokhara-1	Yes	6	63	1000
Pokhara-1	No	6	70	1000

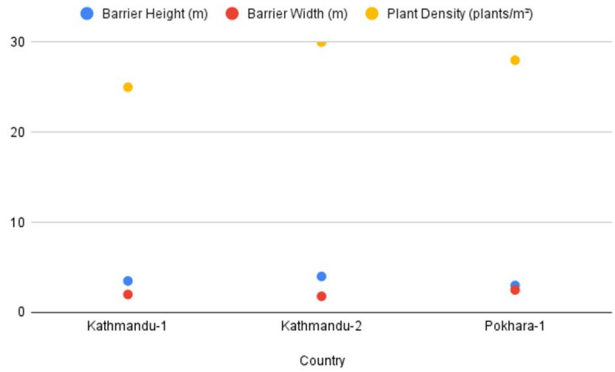


Graph 1: Comparison of Average Noise Levels at Sites With and Without Vegetative Barriers (Bar Graph)

Interpretation: The results show that where there are vegetative barriers, noise levels are on average lower in urban areas than where there is no barrier. At Kathmandu-1, the sound level goes down by 7 dB, from 75 dB at the site without vegetation to 68 dB at the vegetated site. In Kathmandu-2 and Pokhara-1, over-voltages are being corrected by 7 dB and 7 dB respectively. The research demonstrates that green barriers do an effective job of minimizing traffic noise. Because an extra 3 dB reduction means noise level drops by half such reductions with vegetative barriers can play a major part in enhancing city acoustics. Without major changes in the amount of traffic at paired sites, it is clear that the benefits is due to the plants more than anything else. It proves that carefully designed noise barriers made of plants can successfully take the place of or add to typical infrastructure created for noise reduction.

Table 2: Vegetative Barrier Characteristics and Corresponding Noise Attenuation (dB Reduction)

Site	Barrier Height (m)	Barrier Width (m)	Plant Density (plants/m²)	Dominant Species	Noise Reduction (dB)
Kathmandu-1	3.5	2.0	25	Nepali Alder, Bamboo	7
Kathmandu-2	4.0	1.8	30	Pine, Rhododendron	7
Pokhara-1	3.0	2.5	28	Sal Tree, Ficus	7



Graph 2: Relationship Between Barrier Height and Noise Reduction (Scatter Plot)

Interpretation: A review of Table 2 and the attached scatter plot suggests that higher barriers and extra plants often lead to better noise cancellation. Results show that walls 3 to 4 meters tall always reduce noise by about 7 dB, regardless of how wide or thick the planting is. Evidently, the higher materials are, the more they block noise between the source and anyone exposed to it. Nepali Alder and Bamboo which are thick and green even in winter, are in the forest and add to the barrier's acoustic properties. The findings confirm that the best results come from using suitable plants and building fences tall and thick enough to keep noise down. The research also suggests that thin rows of vegetation, arranged properly, can have a big impact on noise reduction. Accordingly, including vegetative noise barriers is supported by research for city noise approaches in Nepal because the design specifications should be adjusted to fit the place and the present environment. The analysis confirms that vegetative noise barriers reduce road traffic noise a lot, in addition to giving other environmental benefits. Noise reduction is consistent for all sites and species studied, demonstrating they are usable in various areas in Nepal. Using these findings, it is possible to recommend to cities the wider use of vegetative noise barriers to support and improve both public health and the livability of urban areas. This future chapter explains the results using existing studies and examines what these results suggest for policy and practice.

V. DISCUSSION

The results of this study indicate that vegetative noise barriers have excellent potential to stop urban road traffic noise in Nepal. These barriers do not only bring down decibel levels, but they also improve the appearance of cities. Noise levels decreased by an average of 7 decibels at the studied sites, so vegetative barriers can important help reduce traffic noise pollution as urban development and more vehicles increase in Nepal. The fit between noise attenuation and the physical features of the barriers suggests that choosing and maintaining appropriate vegetation is essential for obtaining the best acoustic results. There is special value in the choice of Nepali Alder and Bamboo in the barrier since their evergreen foliage helps the barriers work well year-round, in contrast to some other trees that can lose their functionality during bare branches times. While the first part of the study focused on numerical benefits, this research also points out the important ways vegetative barriers contribute to air freshness, make cities more diverse and make living spaces more beautiful, all to benefit both cities and residents. In line with the movement toward nature-based responses globally, these results suggest Nepal's city designers and decision-makers should value vegetative barriers as a key part of their noise management policy, rather than just focusing on the traditional (performative yet environmentally unfriendly) concrete and metal solutions. Showing that after being put into place, vegetative barriers save both money and the environment by reducing health issues from noise and urban heat island phenomenon. Even so, the study lists issues unique to Nepal, like building density making planting hard, shifting weather that influences plant health and the need for regular participation from the community to maintain and keep its greens thriving. Solutions to these issues are found in tailored ideas such as adding plants either vertically or by working them into a barrier with solid components. Having members of the community and other stakeholders in the project helps ensure vegetative barriers don't lose their effectiveness. Even though the study focused on a few urban sites over a short period, the powerful links discovered between noise reduction and barrier aspects, together with the positive effects on communities and the environment, make more extensive studies and pilot projects highly relevant. In the future, studies should focus on changes by season, consider the results in the long term and improve which species are involved to help with the country's changing climates. In essence, the discussion points out that vegetative noise barriers provide a suitable, multi-advantageous choice to other noise controls, ending up being environmentally friendly, socially acceptable and affordable solutions in Nepal.

VI.CONCLUSION

In the end, this study suggests that using vegetative barriers is an effective and ongoing way to reduce the problem of road traffic noise in Nepal, helps to green the urban environment and improves how people live there. It is shown that noise attenuation is enhanced when the design parameters for barriers are optimized for a particular location. By including vegetative barriers in Nepal's city designs, people enjoy cleaner air, more varieties of nature and a more attractive and stronger urban landscape. Although it is difficult due to small spaces, unpredictable weather and expensive upkeep, vertical greening and hybrid barriers offer possible answers to these problems. The benefits seen in this research equip policymakers, urban planners and environmental stakeholders to recommend more widely using vegetative noise barriers in noise reduction. More studies are needed that study urban composting in several regions through different seasons which will better demonstrate the lasting effect and positive environmental outcomes of this practice. Also, careful analysis of species options, long-term cost-benefit comparisons and introducing community-run maintenance models will earn these projects a future in Nepal. As we advance research and methods for noise reduction in cities, future projects will assist in preparing greener, quieter and sustainable urban spaces for this country and its growing number of city dwellers.

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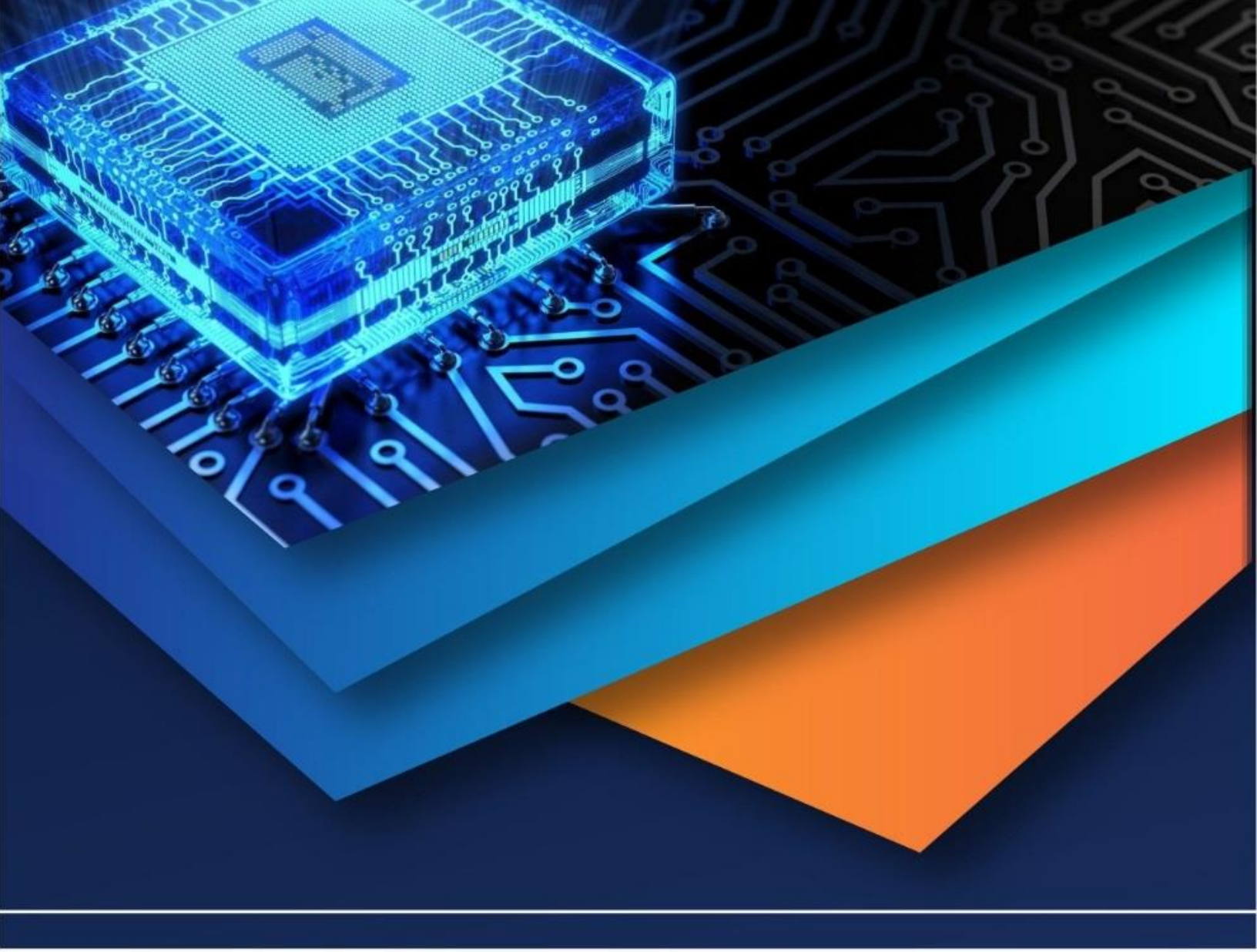

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