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Necessity of Hearing Conservation Program in India: A Systematic Review

Ms. Nisha U V[1], Dr. Satish Kumaraswamy[2]
[1]*Final Post Graduate Student, Dr. M. V. Shetty College of Speech and Hearing Malady Court, Kavoor, Mangalore-15*
[2]*Professor & Principal PhD in Speech, and Hearing, Dr. M. V. Shetty College of Speech and Hearing Malady Court, Kavoor, Mangalore-15*

Abstract: ***Background: Noise-induced hearing loss (NIHL) is a significant public health concern in India. Occupational noise exposure is prevalent in various industries and poses a significant risk to workers' hearing health. Implementing effective hearing conservation programs (HCPs) is essential for preventing and managing NIHL. This systematic review aims to assess the necessity of hearing conservation programs in India and explore their potential impact on occupational noise-induced hearing loss.***
Methods: A comprehensive literature search was conducted across major electronic databases, including PubMed, Google Scholar, Science Direct, ProQuest and Psynet. Studies published between 2009 to 2023 were included if they focused on hearing conservation programs, NIHL prevalence, awareness, or interventions in the Indian context. Relevant articles were selected, and their quality was assessed using with Preferred reporting Items for systematic review and meta-analysis (PRISMA)
Results: The initial search yielded 3102 articles, of which 12 met the inclusion criteria. The included studies highlighted the alarming prevalence of NIHL among Indian workers, particularly in industries such as manufacturing, construction, and textiles. Moreover, they emphasized the lack of awareness and inadequate implementation of hearing conservation programs across various sectors. However, a limited number of studies evaluated the effectiveness and outcomes of existing programs.
Conclusion: The findings of this systematic review underscore the urgent need for comprehensive hearing conservation programs in India. The prevalence of noise-induced hearing loss among workers indicates a significant occupational health challenge. Strengthening awareness campaigns, implementing preventive measures, such as engineering controls and personal protective equipment, and regular audiometric monitoring are crucial for reducing the burden of NIHL.

I. INTRODUCTION

Noise, or unwanted sound, is one of the most pervasive occupational health problems. It is a by-product of many industrial processes. Sound consists of pressure changes in a medium (usually air), caused by vibration or turbulence. These pressure changes produce waves emanating away from the turbulent or vibrating source. Exposure to high levels of noise causes hearing loss and may cause other harmful health effects as well. The extent of damage depends primarily on the intensity of the noise and the duration of the exposure. (Occupational safety and hearing administration 2002).

Noise-induced hearing loss can be temporary or permanent. Temporary hearing loss results from short-term exposures to noise, with normal hearing returning after a period of rest. Generally, prolonged exposure to high noise levels over a period gradually causes permanent damage. (Occupational safety and hearing administration 2002).

Employees who are regularly exposed to loud and harmful noise levels must take part in a hearing conservation program as mandated by the Occupational Safety and Health Administration. Many individuals may not be familiar with what a hearing conservation program entails, why it is crucial, or how it is implemented. It is crucial for those working in environments with potentially damaging noise levels. Actively educate themselves about the hearing conservation program. This is even more important for managers and employers, as their primary responsibility should be ensuring the safety of their employees. The people working in agriculture, mining, construction, manufacturing, utilities, transportation, and the military are more exposed to dangerous levels of noise.

Hearing conservation program must be implemented for all employes who are exposed to noise exceeds 85dBA during the course of 8hrs.

The key elements of a hearing conservation program recommended by OSHA includes:

1) *Monitoring:* An employee is exposed to a time -weighted average of about 85dBfor duration of eight or more hours. OSHA requires the use of careful monitoring.

2) *Audiometric testing:* The employer must establish and maintain an audiometric testing program. The important elements of the program include baseline audiograms, annual audiograms, training, and follow up procedures. Employers must make audiometric testing available at no cost to all employees who are exposed to an action level of 85 dB or above, measured as an8-hour TWA.
3) *Herring protectors:* Employers must provide hearing protectors to all workers exposed to 8-hour TWA noise levels of 85 dB or above. This requirement ensures that employees have access to protectors before they experience any hearing loss. Employers must provide employees with a selection of at least one variety of hearing plug and one variety of hearing muff. Employees should decide, with the help of a person trained to fit hearing protectors, which size and type protector is most suitable for the working environment. The protector selected should be comfortable to wear and offer sufficient protection to prevent hearing loss.
4) *Training:* Employee training is very important. Training should include information about the effect of noise, hearing protection device, explanation about hearing test, hearing conservation program.
5) *Record Keeping:* The employer should document the workers' hearing history like when they started the job, base line audiogram, annual audiogram and evidence of training education attended by the employee.

Hearing conservation programs are extremely important in India to protect workers' hearing in different industries. These programs use techniques like controlling noise levels, encouraging the use of protective equipment, regularly checking workers' hearing, and spreading awareness.

By doing so, these programs have effectively reduced the chances of hearing loss caused by noise. It is essential to continue implementing and enhancing these programs to ensure the long-term health of workers and create safer workplaces across the country.

II. NEED OF THE STUDY

Noise induced hearing loss and its wide-ranging impact on individuals, there is an urgent need for comprehensive hearing conservation in India. This study aims to raise awareness about the magnitude of the problem, identify key challenges, and advocate for policy changes, improved access to services, and increased public education. By prioritizing hearing conservation,

III. METHODOLOGY

A. *Aim*

To systematically review the outcomes of literature that use to find necessity of hearing conservation programs in India.

B. *Objectives*

1) To provide an overview of occurrence of noise induced hearing loss in workers of various sectors in India.
2) To determine the amount of research evidence in effectiveness of hearing conservation program.

C. *Review questions:*

The current review of studies was performed with following review of questions Is hearing conservation program necessary in workers of various sectors in India.

Inclusion and Exclusion criteria

D. *Inclusion criteria*

1) Published in peer-reviewed journals since last 16years (2007-2023)
2) workers who are exposed to noise in Indian scenario.

E. *Exclusion criteria*

1) Studies with unclear findings
2) Duplicate studies were found multiple times in different data base.
3) Studies that published earlier than 2009
4) Studies that include workers from outside India

F. Search Process

The review was conducted in accordance with Preferred reporting Items for systematic review and meta-analysis (PRISMA) standard. Key words like Noise induced hearing loss in factory workers in, noise induced hearing loss in drivers, hearing conservation programs in India, prevalence of noise induced hearing loss in India etc. These search terms were used to look up literature across several databases.

PubMed, Google Scholar, Science Direct, ProQuest and PsyNet database were used to find out the related article for the review. The PRISMA flow chart has four steps: discovering the article, screening the article that has been found, determining their eligibility, and choosing the article for study. These concluding articles were chosen as qualitative studies that met the requirement for inclusion in the current investigation.

G. Data Extraction

The title, data or abstract retrieved from the search strategies were screened to find the studies that matched the inclusion criteria. Potential studies entire texts were then obtained and compared to see if they are qualified. The data that was extracted, covered the following topics :study population, methodology ,participants ,demographic including evaluation technique ,and treatment outcomes .Using pre designed table the data from the selected studies were extracted.

Additionally data on the eligible studies that met the inclusion criteria were retrieved including information on the year of publication, the kind of publication ,the study design ,the research type, the research type, the research topic, the study's origin ,and author profile with their affiliation

H. Selection of article

Identification of articles relevant to the current topic was an important step and using key words to the different electronic databases, 3102 records were identified. Different databases included Google scholar (n=2002), ProQuest (n=498), PubMed (n=450), ResearchGate (102) and Others (n=50). From the total identified articles (3,102), duplicate articles (1,301) were excluded and remaining 1,801 articles were screened for the study. The articles (1,511) that did not match the review topic were also excluded. Remaining 290 articles were taken into consideration for further process and 59 articles were not able to be retrieved and were also not included. 231 articles were assessed for eligibility for inclusion in the current review.

Articles that were published (160) earlier than 2009 were also not included., 40 works who are not exposed to noise were excluded from the study.

An unspecified number of workers and others (27) were also excluded from the study. Finally, only twelve articles fully matched our eligibility criteria and were selected for the study. These twelve articles are the latest research papers that are published in journal of audiology 2009 to 2022. These all papers include noise induced hearing loss in workers among various sectors in India and hearing conservation programs.

I. Study Design And Characteristics

Papers selected for the current review were all pre and posttest research design depending on comparative, observational, training survey and experimental study (Table 1).

Shows hearing conservation programs in various sectors. Singh (2019) included 110 participants in which 60 were different craft trades and 50 were referend group. Singh, Bhardwaj, Kumar(2012) included 572 20workers. Dewangan , Patel , (2023) included 60 workers into two groups (experimental-30,controlled group 30), Singh, Bhardwaj, Kumar(2013) included 572 20workers. Bennet, Joseph' Mehazabeen' Monisha included 174 workers. Basheer , Bhargavi , Prakash(2019) included 57 workers, Chandrasekhar, Pawar, Patil, (2009) included 420 workers. Rajan, Mathew, Shiju (2021) included 13 workers. Kumar, Varghese, Mohan, Singh, Mahajan (2005) included 100 works. Cherian, Bhargavi (2022) included 720 workers. Edward, Mukesh, Manohar, Sai, Gangadhara, Kallikadan (2016) include114 workers. Majumder, Mehta (2009) included 30 workers. Figure 1: Shows the Diagram that illustrates the PRISMA (Moher, Liberati, Tetzlaff, & Altman, 2020) Process of identification, screening, and selection of the articles for the present study.

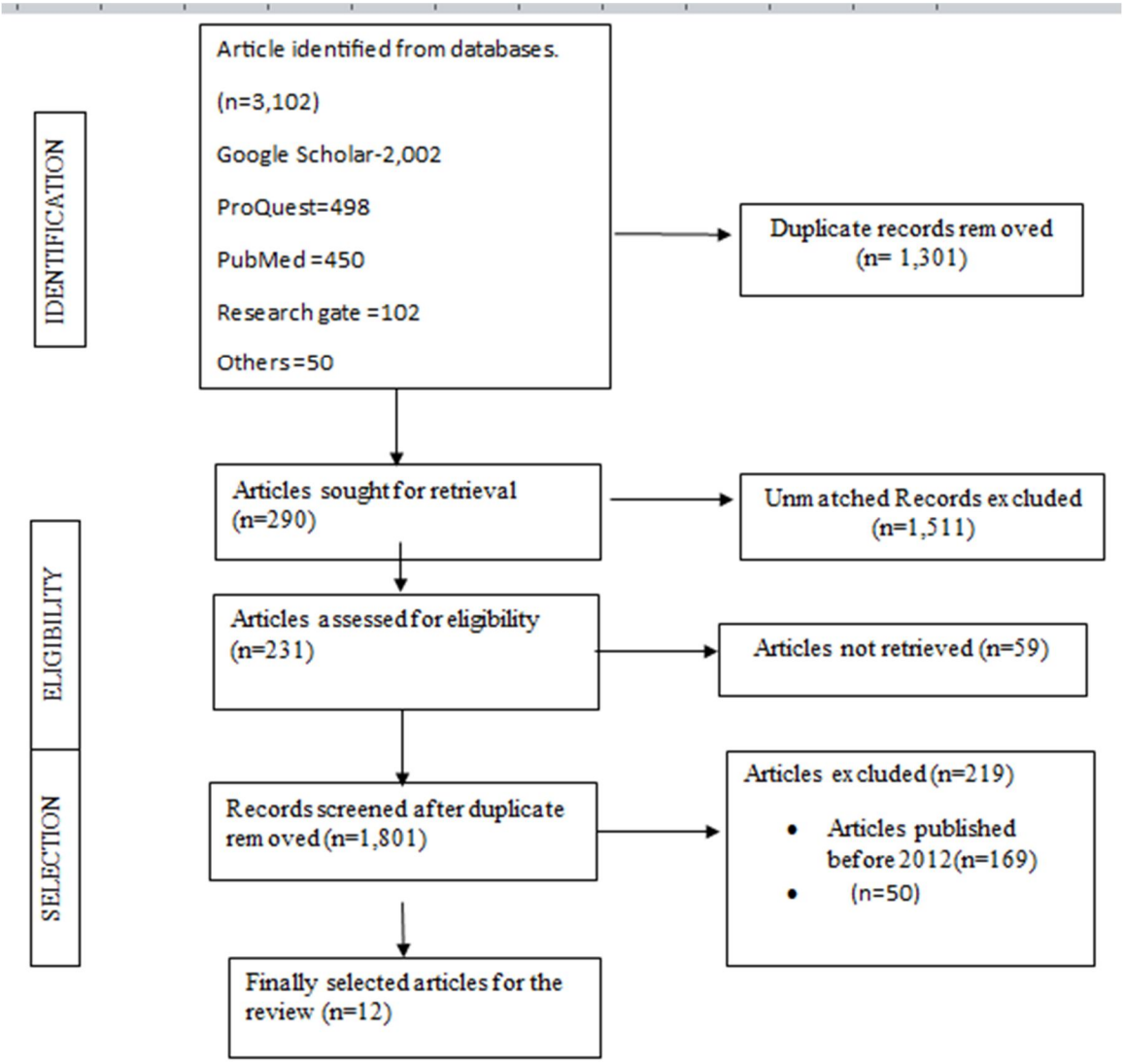

Figure 1: Shows the Diagram that illustrates the PRISMA.

(Table 1). Shows hearing conservation programs in various sectors

Author year	Title of journal /book	Paper title	Aim of the study	Study design	Study sample size/type	Technique used	Assessment tool	Finding
Ashish Kumar Singh-2019	Ergonomics	Comparative assessment of shift in hearing threshold among handicraft operatives in India	Assess the noise exposure and loss in hearing threshold (HT) due to the occupational use of hand tools used for handicraft work.	case-control exploratory study	Sixty male participants involved in different crafts trade and a reference group of 50 office workers were selected.	Audiometric tests were conducted to compare the HT between both the groups.	Audio metric test	Audio metric tests were done to compare the hearing ability of two groups. The workers who were exposed to more noise had moderate hearing problems in the range of 1500-

								6000 Hz, which was consistent with the amount of noise they were exposed. To address this issue, recommend making changes to the tools used, implementing hearing conservation programs and the practice of personal protective equipment.
Lakhwinder Pal Singh, Arvind Bhardwaj, Deepak Kishore Kumar 2012	Noise health	Prevalence of permanent hearing threshold shift among workers of Indian iron and steel small and medium enterprises: a study	Determine the prevalence of permanent hearing threshold shift among the workers engaged in Indian iron and steel small and medium enterprises (SMEs) and compared with control group subjects.	questionnaire survey	572 workers	Audiometric test	Audio metric test	The analysis found that more forging workers had significant hearing loss compared to workers in other activities. The study showed alarming signs of noise-induced hearing loss, especially among forging workers. To reduce occupational exposure to noise, we can use effective measures like engineering controls, administrative controls, and personal protective devices or more practical way to protect industrial workers from

								workplace noise is to have a comprehensive hearing conservation program. This program should include training, regular hearing tests, job rotation, and the use of hearing protection devices.
Lakhwinder Pal Singh Arvind Bhardwaj, Kishore Kumar Deepak 2013	Human factor	Occupational noise-induced hearing loss in Indian steel industry workers: an exploratory study	Exploring the current level of hearing protection and subsequently determined the prevalence of occupational noise-induced hearing loss among casting and forging industry workers.		572 workers	Audiometric test	questionnaire survey audiometric test	The analyses revealed that higher prevalence of significant hearing loss among the forging workers compared with the workers associated with the other activities. In the Indian steel industry, workers are exposed to a lot of noise at work. It's important to provide special ear protectors for workers involved in forging. To address this issue, a comprehensive hearing protection program should be implemented. This program should include training, regular hearing tests, job

								rotation, and the use of hearing protection devices.
Krishna Narayan Dewangan [1], Thaneswer Patel [1], Lalremruata 2023	Noise health	Noise exposure and hearing loss among tractor drivers in India	The aim of this study was to measure noise intensity at the tractor drivers' ear level and hearing loss among tractor drivers.		30 tractor drivers and 30 control group subjects.	Audiometric test	Interview Audio metric test.	The tractor drivers were exposed to loud noises ranging from 91.7 to 97.5 dB(A). The result revealed that hearing ability was significantly worse compared to the subjects in the control group. The left ear of the tractor drivers was more affected than the right ear as the tractor drivers. To address this issue, a comprehensive hearing protection program should be implemented. .
Bennet Elsa Joseph [1], Haleem Mehazabeen [1], Monisha U	Noise health	Noise pollution in hospitals - A study of public perception	The aim of the study was to determine awareness of public regarding noise pollution in hospitals, its health effects and mitigation measures.	Survey	174 workers	Survey	survey	174 completed questionnaires were received and analyzed, out of which 108 were general public and 66 were Audiologists. The data analysis revealed that the public is aware of the presence of noise in hospitals, some of its overt health effects and measures that can be taken to

								control the noise pollution in hospitals. Only 22.7% Audiologists who participated in the study were aware of the more technical aspects like permissible noise level in hospitals and their response was similar to that of the general public. Though the public is aware of some of the basic facts related to noise in hospitals, there is a need to create public awareness and to train Audiologists regarding hearing conservation program in hospital setups.
Ramziya Basheer[1], P G Bhargavi[2], Hari P Prakash 2019	Noise health	Knowledge, attitude, and practice of printing press workers towards noise-induced hearing loss	Identify the knowledge, attitude, and practice (KAP) of printing press workers towards NIHL.	Cross sectional study	57 workers	Survey	Kap questionnaire	The responses obtained from workers showed inadequate knowledge, negative attitudes in certain subdomains and poor practice. He findings from the present study sheds light on the dearth of awareness in printing press workers on hearing conservation and

								need of training programs to educate the printing press workers towards the effects of NIHL.
Amar M, Dhere Chandra sekhar B Pawar, D hanraj A Patil, Jan ardan A Pawar 2009	Journal of environm ent science engineeri ng	Noise induced hearing loss (NIHL) in saw mill and printing press workers in Akluj Town of Solapur district	The present research work reveals the NIHL problem in workers related to saw mill and printing press in Akluj town, Solapur district of Maharashtra state.		420 workers	Audiometric test	Audio metric test	The average NIHL are found in 28% saw mill workers and 13% in printing press workers. It is reported that medicine treatments are not very useful for curing NIHL. Today's available tool which prevents NIHL is ear plugs and ear muffs, which are suitable for preventing NIHL problems in industrial workers.
A Rajan, S Nayak, L Mathew, R Shiju 2021	Research gate		Current study aims to assess the NIHL in Indian Travelling Ticket Examiners.		13 workers		Audio logica l evalua tion	Train ticket examiners (TTEs) had mild hearing loss, which was strongly linked to their work experience. It is crucial to implement a suitable and effective Hearing Conservation Program for railway employees
Adarsh Kumar NNMath ur, Mathew	American journal of audiolog y	Effect of tractor driving on hearing loss in farmers	Study compares the hearing status of tractor driving farmers	Cross sectional study	100	Audiometric test	Audio metric test	50 farmers reported hearing problems based on their own perception.

Varghese, Dinesh Mohan, JKSingh, Puneet Mahajan 2005		in India	(TDFs) (study group) and non-tractor driving farmers (NTDFs) (control group) matched for age, sex, generic/ethnic group, land holding, education levels, and work routines.					However, audiogram analysis showed a higher prevalence of abnormalities in TDFs. TDFs had more often high frequency hearing loss when compared to NTDFs (14). The noise levels observed on tractors in different operations were in the range of 90. Tractor noise levels exceeded the recommended safe limits of OSHA and NIOSH prescribed standards
Jincy Mary Cherian Bhargavi P.G 2022	Research square	Cultural adaptation and administration of public awareness questionnaire on hearing health and hearing loss in Karnataka	The study aims to culturally adapt, administer, and assess public awareness of Karnataka's hearing loss and hearing health.	Cross-sectional survey design	720	Questionnaires (Quota sampling)	questionnaires	Around 70% of the respondents answered most of the statements correctly, but there were gaps in their knowledge about specific important topics. There is a lack of public awareness about the impact of ringing in the ears on daily activities, and most people are unaware of guidelines for reducing exposure to loud noises. These

								findings highlight the need for informative initiatives to reduce noise and increase awareness.
Edward, Mukesh Manohar, Sai Somayaji, Gangadhara Kallikkadan, Hebin 2016.	journel	Prevalence, awareness, and preventive practices of noise-induced hearing loss in a plywood industry	To determine the prevalence of occupational NIHL in the selected industry To evaluate the awareness and practices regarding prevention, of NIHL in the selected industry •To emphasize the critical importance of educating industry workers regarding NIHL and its prevention.	Cross sectional study	114	Questionaire	Pure tone audio metry	In the selected plywood industry, there were 114 workers involved in the study .57 were confirmed to have noise-induced hearing loss (NIHL), which accounted for 51.4% of the cases. Considering the lack of awareness regarding NIHL and preventive measures among the noise-exposed workers in this study, it is critically important to provide health education and implement prevention methods. This includes providing earplugs, earmuffs, regular audiometric screenings, establishing legislative standards for exposure time to noise, and

								ensuring their implementation.
J. Majumder, C.R. Mehta 2009	International audiology of industrial ergonomics	Excess risk estimates of hearing impairment of Indian professional drivers	Estimate an *excess risk* of hearing impairment of professional drivers in Kolkata city of India.		30			The values of estimated average excess risk indicated that hearing damage of professional drivers was expected to occur sooner at 3 and 4 kHz frequencies than losses at lower frequencies. It was concluded that the occupational hazards of professional driving significantly increased hearing threshold levels of drivers as compared to office workers.

Table 2 shows over all study finding of necessity of hearing conservation program in various sectors.

Population studied	Number of papers	Total number of participants	percentage	Overall findings
Industrial workers	7	1425	58.3	A complete hearing observation program including training, audiometry, job rotation and use of hearing protection device is the most feasible method for the protection of industrial workers from prevailing noise in workplace environments.
Drivers	3	730	25	Tractor noise level should not be exceeded the recommended safe limits of OSHA and NIOSH
Professionals	1	174	8.3	Create public awareness and train audiologist regarding to the hearing conservation program
Railway employes	1	13	8.3	The interactive effects of occupational NIHL, ageing and recreational noise exposure may ultimately result in a handicapping situation in these railway employees' professional and personal lives. Hence the enrollment of Railway employees in an appropriate and effective Hearing Conservation Program is a necessity

Outcome

Table 3 shows the outcomes of various hearing conservation programs.

Authors and Year	Outcome of the studies
Singh (2012), Dewangan et al (2019), Rajan et al (2012), Majumder et al (2009). Kumar et al (2005) Singh et al (2010), Singh et al (2013), Amar et al, Edward et al (2016)	To reduce occupational exposure to noise, use effective measures like engineering controls, administrative controls, and personal protective devices or more practical way to protect industrial workers from workplace noise is to have a comprehensive hearing conservation program. This program should include training, regular hearing tests, job rotation, and the use of hearing protection devices., establishing legislative standards for exposure time to noise,
Joseph et al (2022), Basheer et al (2019), Cherian et al (2022)	Educate the workers about the effects of noise induced hearing loss and the importance of hearing conservation programs.

IV. SUMMERY AND CONCLUSION

The current systematic review focuses on necessity of hearing conservation programs in India. Hearing conservation programs are extremely important in India to protect workers' hearing in different industries. These programs use techniques like controlling noise levels, encouraging the use of protective equipment, regularly checking workers' hearing, and spreading awareness. these programs have effectively reduced the chances of hearing loss caused by noise. It is essential to continue implementing and enhancing these programs to ensure the long-term health of workers and create safer workplaces across the country.

The reviewed studies provide evidence of the positive impact of comprehensive programs in various industries. However, continuous efforts are required to raise awareness, ensure compliance, and establish standardized guidelines for sustained success in hearing conservation.

V. LIMITATIONS

1) Limited numbers of articles have been taken for this systematic review.
2) Considered studies on Indian population only.

VI. FUTURE DIRECTIONS

More studies can be included for systematic review to get good statistical evidence.

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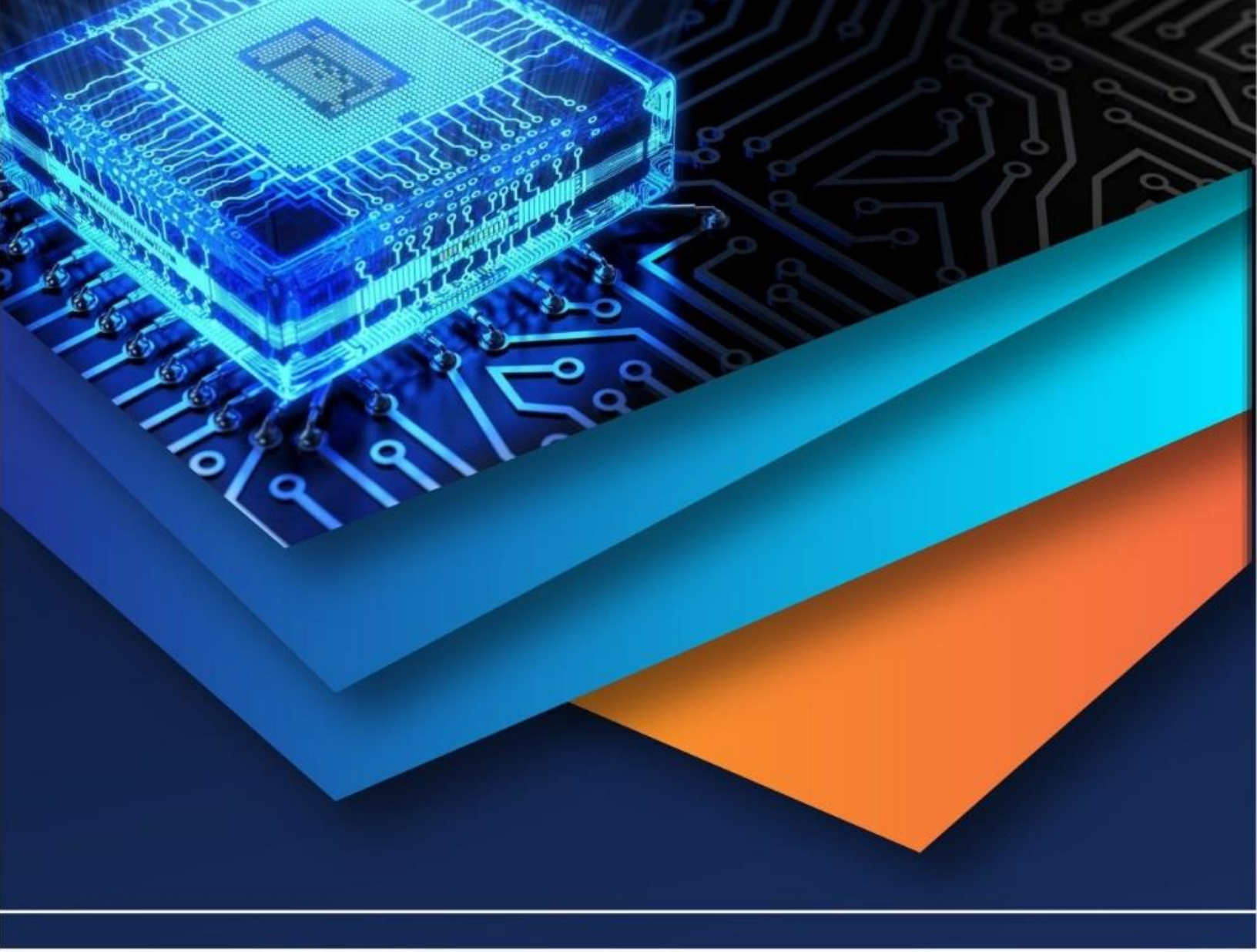

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