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An Integrated SWOT Analysis of Waste Collection and Transportation Systems in Chitrakoot (UP & MP)

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Abstract: ***This study evaluates the municipal solid waste (MSW) management system in Chitrakoot, which encompasses Nagar Palika Chitrakoot (Uttar Pradesh) and Nagar Parishad Chitrakoot (Madhya Pradesh), for the year 2024, using a structured analytical framework based on SWOT analysis. The findings highlight that waste generation has increased significantly in both municipalities due to population growth, tourism, and changing consumption patterns. Waste collection is primarily conducted through door-to-door services and manual scavenging, with the support of available sanitation workers and basic transportation services. However, the system faces significant challenges, including limited source segregation, inadequate landfill management, lack of modern treatment technologies, and insufficient infrastructure for recycling and proper disposal. Opportunities exist in adopting decentralized composting, biogas systems, waste-to-energy options, multi-bin waste sorting, and public-private partnerships, as well as in strengthening community awareness. Threats include increasing waste volumes, uncontrolled dumping, environmental pollution, poor enforcement of waste regulations, and associated health risks. Overall, this study highlights the need for modernized infrastructure, improved technology integration, policy compliance, and active community involvement to improve the sustainability and efficiency of municipal solid waste management in Chitrakoot.***
Keywords: Municipal Solid Waste, Waste Management, SWOT analysis, Waste Composition, Sustainability

I. INTRODUCTION

Rapid urbanization in the 21st century has intensified municipal solid waste (MSW) management challenges, crucial for urban sustainability and public health. Economic and industrial growth, coupled with rising living standards, has increased waste generation, projected to reach 3.4 billion tons globally by 2050 (Kaza et al., 2018). SWOT analysis, a strategic planning tool recognized by USEPA, is used to assess internal and external factors influencing MSW management (Srivastava et al., 2005; Greene & Tonjes, 2014). Studies highlight that SWOT helps identify strengths such as existing infrastructure, supportive policies, and public participation; weaknesses like low awareness, limited funding, and inadequate technology; opportunities including government support and private partnerships; and threats such as population growth and environmental degradation (Sari et al., 2021). Despite ecological concerns, landfilling remains the dominant disposal method (Koda et al., 2015). Moreover, waste collection and transportation—constituting 70–80% of total MSW costs—are often neglected by authorities, despite being influenced by vehicle type, load, and terrain (Heinold & Meisel, 2018; Erdem, 2022). Thus, SWOT analysis provides an effective framework for evaluating existing MSW systems and identifying key areas for improvement (Allesch & Brunner, 2014)

A. Objective

The study's main objective is to make a SWOT analysis for sustainable municipal solid waste management in Chitrakoot.

II. METHODOLOGY

The main elements examined include waste generation, composition, collection, separation, transportation, and disposal to assess the current state of waste management. Furthermore, the research cites a SWOT-based strategic management analysis for solid waste recycling in Zahedan (Aich and Ghosh, 2016). Furthermore, the research cites a SWOT-based strategic management analysis for solid waste recycling in Zahedan (Mor et al., 2016; Aich and Ghosh, 2016). It emphasizes the strategy formulation phase, identifying internal strengths and weaknesses, external opportunities and threats, and defining long-term objectives.

Strategic planning includes decisions on business expansion, asset allocation, and potential mergers to improve recycling performance.

A. Study Area

Chitrakoot Dham, also known as (Karwi is), located in Chitrakoot district, Uttar Pradesh, and functions as a Nagar Palika Parishad. As per the 2011 Census, it covers an area of about 21.96 km² with a population of 23,316. Geographically, it lies between 24°48′– at 25°12′ 49″N latitude and 80°58′–81°34′ 51′36″E longitude, within the Bundelkhand region, known for its semi-arid climate and religious significance, attracting large numbers of pilgrims year-round, which adds to solid waste management challenges. Chitrakoot in with a population of 95,894 (Census, 2011). The Madhya Pradesh, part of the Satna district, is administered by part of Chitrakoot, designated as a Nagar Parishad and divided into 15 wards. It, lies between 23°58′– at 25°12′ 09′30″N latitude and 80°21′–81°23′ 51′36″E longitude, covering about 1,584 km² with a population of 23,316 (Census 2011) housing 23,316 residents (Census, 2011). Both areas represent key administrative and cultural divisions of the Chitrakoot region.

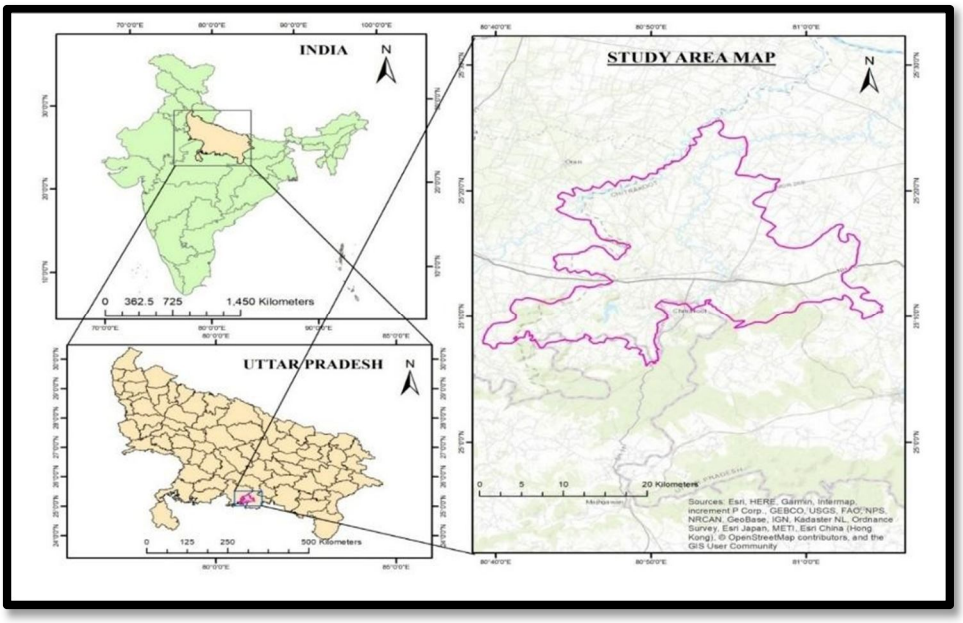

Figure :1 Study area of map

B. Findings From SWOT Analysis3. Findings From SWOT Analysis

SWOT analysis always seeks to interpret the better preparation of strategic planning proposal for three sanitation infrastructure, theses solid waste management, access to toilet, wastewater management.

Detail findings from SWOT analysis are as below:

1) SWOT-Based Assessment Framework

2) Solid waste management (MSWM) SWOT questionnaire

a) Section A: General information

- Name (optional)
- Designation /Role:
- Municipal officer☐ Sanitation worker ☐ Local resident ☐ NGO/private contractor☐
- Ward/area:
- Date

b) Section B: SWOT-based questions

➢ Strengths

Please rate the presence of effectiveness of the following positive features (0=Not at all, 10 =very strong):

Table 1 : Assessment of Strength Factors in (MSWM) in Chitrakoot

Statement	Score (0-10)
S1: Established location of the solid waste management centre.	
S2: Regular waste collection is carried out door-to -door in residential areas	
S3: Cost-effective and low-maintenance composting method.	
S4: Implementing effective awareness and training program to promote waste management in the division.	
S5: Availability of finance.	
S6: Established Waste Collection Workforce.	

Average strengths score = (sum of above ÷ 4) =

- Weaknesses

Rate the severity of the following problems (0= No issues,10=very serious):

Table 1.1: Severity rating of identified weaknesses in the MSWM system

Statement	Score (0-10)
W1: Low management of waste dumping.	
W2: Inefficient food waste sorting.	
W3: Shortcomings in compost manufacturing process.	
W4: Lack of recycling option for lunch sheet issue.	
W5: Limited technological advancements in waste processing.	
W6: Insufficient Waste Bin Infrastructure.	
W7: Inefficient Street Cleaning Practices.	
W8: Unscientific Waste Disposal: Open Dumping's Impact	

Average weaknesses score= (Sum ÷4) =

- Opportunities

How much potential is there for improvement in these areas? (0=No potential,10=High potential):

Table 1.2: Assessment of opportunity potential in (MSWM) in Chitrakoot

Statement	Score (0-10)
O1: Installation of a biogas unit within solid waste management center	
O2: Getting support from the government and industry groups.	
O3: Introducing five bins for waste separation.	
O4: Sustainable Waste Management via WTE in Chitrakoot.	
O5: Enhancing Chitrakoot Waste via Public-Private Collaboration.	
O6: Awareness Programs Driving Cleanliness in Chitrakoot.	

Average opportunities score= (Sum ÷ 4) =

- Threats

How serious are these exist in threats? (0 =Not serious, 10=Extremely serious):

Table 1.3: Assessment of threat severity in municipal solid waste management (MSWM) in Chitrakoot

Statement	Score (0-10)
T1: Open Dumping: Endangering Water, Air, and Communities.	
T2: Waste production is on the rise due to changing consumption pattern and population growth.	
T3: Uncontrolled waste disposal generates some health issues.	
T4: Chitrakoot Managing Escalating Waste from Urbanization and Population	
T5: Dumping off waste in open drain is more than dumping in bins given by NagarPalika.	
T6: Numerous waste-related legislation and programs are poorly implemented.	

Average threats score = (Sum ÷ 4) =

c) Section C: Final rating (Optional)

Based on your experience, how would you rate the overall performance of the waste management system in your area?

- Good
- Average
- Poor
- Very poor
- Excellent

C. SWOT analysis – Chitrakoot solid waste management

This document presents a concise SWOT analysis of municipal solid waste management (MSWM) in Nagar Palika Chitrakoot (Uttar Pradesh) and Nagar Parishad Chitrakoot (Madhya Pradesh). Using a structured questionnaire framework, it systematically evaluates current MSWM practices, identifying strengths that support effective waste collection and disposal, and weaknesses that hinder efficiency and sustainability. The analysis also highlights opportunities for improvement through technology, community involvement, and policy support, while pinpointing threats like environmental degradation and institutional issues. These insights aim to guide policymakers and local authorities in designing targeted, context-specific strategies to enhance sustainable waste management in both regions.

1) Interpretive analysis of SWOT elements in municipal solid waste management

The SWOT analysis highlights the overall performance of the municipal solid waste (MSW) management system. Strengths (23.1%) reflect positive aspects, such as separate waste collection centers and door-to-door collection services. Weaknesses (30.8%), the highest percentage, point to key shortcomings, such as the need for biogas plants, waste separation into multiple containers, and strengthening public-private partnerships. Opportunities (26.9%) highlight the potential to improve sustainability, public health, and urban development through targeted investments and coordinated planning. Threats (19.2%), although fewer in number, remain significant due to the health risks and environmental pollution posed by open-pit landfills. Overall, the analysis suggests progress, but highlights the need for targeted improvements and strategic interventions.

Table: 1.4 Interpretive analyses of SWOT elements in municipal solid waste management

Category	Proportion	Interpretation
Strength	23.1	Shows that approximately a quarter of the information is positive aspects of the waste management system such as, established selective waste collection centres (SCCs)and door-to- door collection
Weaknesses	30.8	Emphasizes growth opportunities including a biogas unit a 5 -bin system and public -private partnerships.
Opportunities	26.9	The Opportunities section highlights key pathways to improve municipal solid waste management, support public health, and encourage sustainable urban development. Realizing to realize these benefits , strategic planning is targeted investments, and active cooperation among stakeholders.
Threats	19.2	Suggest that relatively fewer threats have been identified but they are still significant (health impacts, pollution from open dumping)

2) Weighted scoring assessment of SWOT factors

When evaluating options or planning interventions, weights help prioritize. Suppose you give each category a score based on its impact or urgency (on a scale of 1-10).

Table: 1.5 score-based assessment of SWOT factors in municipal solid waste management

Category	Proportion (%)	Decimal	Score (out of 10)	Weighted score
Strengths	23.1	0.231	6	0.231× 6=1.386
Weaknesses	30.8	0.308	3	0.308× 3=0.924
Opportunities	26.9	0.269	8	0.269× 8=2.152
Threats	19.2	0.192	2	0.192× 2=0.384

Total Weighted Score=4.846/10→This is composite indicator of overall system performance **2.7 Category-based point assessment**

The category-based point assessment (Table 5.7) shows that weaknesses (8 points) dominate municipal solid waste management in Chitrakoot, followed by opportunities (7), Strengths (6) and threats (5). This indicates major operational gaps but also strong potential for improvement with existing strength and manageable threats guiding strategies for sustainable waste management.

Table:1.6 Category number of points

Category	Number of points	Visual meaning
Strengths	6	There is solid foundation, but fewer than the weaknesses.
Weaknesses	8	The highest score highlights the most significant problem.
Opportunities	7	Demonstrates strong area for potential future development.
Threats	5	Highlights the fewest threats, although they still have a considerable impact.

D. Weighted scoring assessment of SWOT factors

When evaluating options or planning interventions, weights help prioritize. Suppose you give each category a score based on its impact or urgency (on a scale of 1-10).

Table: 1.7 score-based assessment of SWOT factors in municipal solid waste management

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E. Category-based point assessment

The category-based point assessment (Table 5.7) shows that weaknesses (8 points) dominate municipal solid waste management in Chitrakoot, followed by opportunities (7), Strengths (6) and threats (5). This indicates major operational gaps but also strong potential for improvement with existing strength and manageable threats guiding strategies for sustainable waste management.

Table: 1.8 Category number of points

Category	Number of points	Visual meaning
Strengths	6	There is solid foundation, but fewer than the weaknesses.
Weaknesses	8	The highest score highlights the most significant problem.
Opportunities	7	Demonstrates strong area for potential future development.
Threats	5	Highlights the fewest threats, although they still have a considerable impact.

III. SWOT ANALYSIS OF MSW MANAGEMENT PRACTICES

Using SWOT analysis, the study aimed to identify gaps in the existing MSW management practices and ways to improve them.

Table 1.9: SWOT analysis on waste management system

Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
S1: Established location of the solid waste management centre.	W1: Low management of waste dumping.	O1: Installation of a biogas unit within solid waste management center	T1: Open Dumping: Endangering Water, Air, and Communities.
S2: Regular waste collection is carried out door-to-door in residential areas.	W2: Inefficient food waste sorting.	O2: Getting support from the government and industry groups.	T2: Waste production is on the rise due to changing consumption pattern and population growth.
S3: Cost-effective and low-maintenance composting method.	W3: Shortcomings in compost manufacturing process.	O3: Introducing five bins for waste separation.	T3: Uncontrolled waste disposal generates some health issues.

S4: Implementation of effective awareness and training programs promoting waste management in the division.	W4: Lack of recycling option for lunch sheet issue.	O4: Sustainable Waste Management via WTE in Chitrakoot.	T4: Chitrakoot Managing Escalating Waste from Urbanization and Population
S5: Availability of financial support.	W5: Limited technological advancements in waste processing.	O5: Enhancing Chitrakoot Waste via Public-Private Collaboration.	T5: Dumping off waste in open drain is more than dumping in bins given by NagarPalika.
S6: Established and trained waste collection workforce.	W6: Insufficient Waste B in Infrastructure.	O6: Awareness Programs Driving Cleanliness in Chitrakoot.	T6: Numerous waste-related legislation and programs are poorly implemented.
	W7: Inefficient Street Cleaning Practices.		
	W8: Unscientific Waste Disposal: Open Dumping's Impact		

1) Strength

Chitrakoot Nagar Palika (UP), an organized municipal solid waste (MSW) management system is in place, handling 13.88 tons of waste per day. Waste is collected through door-to-door services at three designated locations and transported using 15 collection vehicles (0.463 tons capacity, two trips per day 30 trips total) and four tractors (0.578 tons capacity, six trips per day 24 trips total). To improve sustainability, the adoption of waste-to-energy, composting, and recycling programs is recommended, supported by public awareness campaigns and strict enforcement of waste disposal regulations. In Chitrakoot Nagar Parishad (M.P.), approximately 3.22 ton of waste per day (98.03 tons/month 1,176.32 ton/year) is managed through a structured system comprising two tractors (two trips/day, one ton/trip), two loaders (one to two trips/day, two ton/trip), and four pickup trucks/vans (three trips/day, one ton/trip). This organized collection and transportation network ensures efficient use of resources and effective management of municipal solid waste (MSW). Promoting recycling, composting, waste-to-energy options, and raising community awareness can further reduce reliance on landfills and contribute to a cleaner, healthier urban environment in Chitrakoot.

2) Weaknesses

Despite progress, several weaknesses hinder effective waste management in Chitrakoot. The landfill sites suffer from poor management, irregular dumping, and odor issues, posing long-term environmental risks. Manual, non-technical food waste sorting results in compost contaminated with heavy metals and plastics, lowering its quality and market value. Compost production lacks standardization, with improper aeration, leachate management, and excessive soil content leading to substandard outputs. The absence of recycling facilities for plastic materials, particularly lunch sheets, aggravates soil and groundwater contamination. Technological limitations further constrain processing efficiency and compost quality. Inadequate waste bin infrastructure leads to littering and weak public participation in waste segregation, while irregular street cleaning reduces sanitation and increases disease risks. Additionally, open dumping and uncontrolled waste burning contribute to pollution and deteriorate urban aesthetics, highlighting the need for scientific and regulated waste disposal practices.

3) Opportunities

Chitrakoot has several strong opportunities to enhance its improve SWM system. Establishing a through biogas unit can utilize the 70%production from organic waste fraction, reducing methane emissions and producing renewable energy. Increased, expanded government and industry support provides a foundation for infrastructure development, particularly for, and better landfill improvement and recycling facilities. Introducing a infrastructure. Adopting five-bin segregation system can significantly improve source-level separation, facilitating efficient composting and recycling.

Adopting waste-to-energy (WTE) technologies offers a sustainable approach to minimize waste volume can enhance efficiency, while PPPs and recover energy, particularly relevant in the agricultural context of Madhya Pradesh. Public–Private Partnerships (PPPs) can bring technological awareness programs can boost innovation, financial investment funding, and managerial expertise to improve system performance. Additionally, extensive awareness programs involving schools, NGOs, and media can foster behavioral change, community engagement, and long-term environmental responsibility.

4) Threats

Several external threats challenge the sustainability of SWM in Chitrakoot. Open dumping remains a major concern, leading to groundwater contamination, air pollution, and disease outbreaks among nearby residents. Increasing waste generation driven by urbanization and changing consumption patterns is overwhelming existing infrastructure. Poor implementation of waste-related laws and insufficient enforcement have perpetuated unsystematic dumping and inadequate waste treatment. Rapid urban growth without matching infrastructure upgrades further exacerbates waste accumulation and pollution. The disposal of waste in open drains, instead of designated bins, contaminates water bodies and spreads vector-borne diseases, posing serious health hazards. Finally, weak public participation and limited awareness hinder the success of waste management programs, underlining the need for stronger regulatory enforcement, public education, and stakeholder collaboration to achieve sustainable waste management in Chitrakoot.

A. Transportation and Disposal

Municipal solid waste (MSW) management in Chitrakoot faces challenges similar to those observed across India, where resource scarcity, financial constraints, and lack of technical capacity limit the adoption of advanced systems such as waste-to-energy (WTE) (Kausal et al., 2012; Sharholy et al., 2008). In Chitrakoot Nagar Palika (Uttar Pradesh), approximately 13.88 ton of waste per day is managed through a structured door-to-door collection system, supported by a fleet of collection vehicles, tractors, wheel loaders, and vans, which enables the regular transportation of waste from households to final disposal sites. In Nagar Parishad Chitrakoot (M.P.), approximately 3.22 ton of waste per day is managed using tractors, wheel loaders, and vans, providing basic coverage but highlighting the need for scalable infrastructure as waste generation increases. For waste disposal, Chitrakoot (Uttar Pradesh) directs its waste to a 1.2-hectare landfill in Marjadpur, operated by 280 waste collectors and equipped with 150 containers. Despite its moderate efficiency, poor segregation and reliance on conventional landfills continue to hinder its performance. In contrast, Chitrakoot (M.P.) disposes of its waste at a 1.6-hectare landfill in Rajula, operated by 112 Safai Karamcharis and using only 25 containers, resulting in lower operational efficiency and frequent unregulated landfills. To address these limitations, a new 1.6-hectare waste management and disposal facility was constructed near the Hanuman Dhara flyover, providing more space for waste reception and better logistical support for transportation and future treatment activities. Strengthening recycling, composting, and waste-to-energy (WTE) initiatives, along with public awareness and strict enforcement of waste policies, will further improve sustainability and reduce landfill dependence in both Chitrakoot urban municipalities.

Figure : 2 Waste transport at dumpsite, Chitrakoot (U.P.) Figure:3 Door-to-door waste collection, Chitrakoot (M.P.)

IV. CONCLUSION

The comprehensive assessment, based on a SWOT analysis of municipal solid waste management in Chitrakoot (Uttar Pradesh and Madhya Pradesh) for 2024 and supported by a structured survey of municipal staff, sanitation workers, households, and local stakeholders, highlights significant operational strengths but also reveals significant systemic limitations.

In Nagar Palika Chitrakoot (Uttar Pradesh), total annual waste generation reached 5,007.94 ton/year with an average daily production of 13.88 ton/day reflecting rapid urban growth, tourism pressure, and changing consumption patterns. In Nagar Parishad Chitrakoot (M.P.), annual MSW generation is approximately 1,176.32 tons/year corresponding to a daily waste load of approximately 3.22 tons/day indicating a lower but steadily increasing waste flow. The questionnaire responses further reinforced the observed shortcomings in waste separation practices, transportation efficiency, workforce skills, and public participation, while also validating the strengths of well-established door-to-door collection systems and the availability of trained healthcare workers. Major weaknesses, such as limited waste separation, inadequate landfill management, insufficient treatment technologies, and low recycling capacity, continue to limit the system's efficiency. Opportunities such as decentralized composting, biogas production, the adoption of waste-to-energy systems, multi-container systems, and public-private partnerships offer significant potential for modernization. Meanwhile, increasing waste volumes, unregulated dumping, poor regulatory enforcement, and environmental health risks pose persistent threats. Overall, the findings demonstrate that while a basic framework for municipal solid waste management (MSWM) exists in both ULBs, the questionnaire-based perspectives emphasize the urgent need for infrastructure improvements, science-based treatment facilities, better technology integration, stronger policy enforcement, and active community engagement to achieve a sustainable and resilient waste management system for Chitrakoot.

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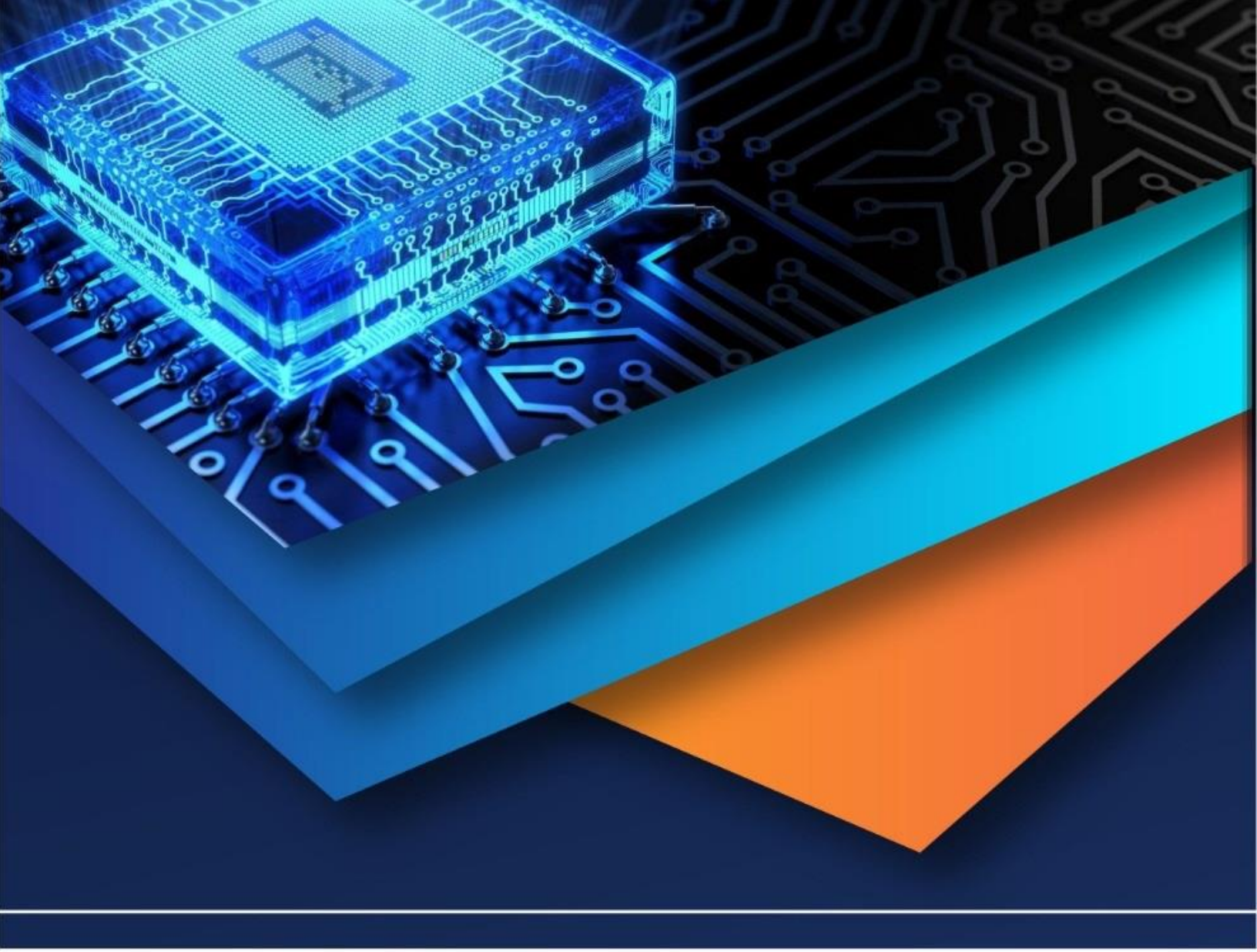

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