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# Application of Lean Tools in Ceramic Industry: A Review

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***Abstract:*** ***To improve productivity is important to any company since it influences their outputs and profits. This review paper covers the methods for productivity improvement; Lean manufacturing tools are one of the most influential & most effective methodologies for eliminating wastes (MUDA) and getting more output with less input. Lean focus on elimination of all NVA (Non-Value Added Activities) in any organization and helps to reduce cost, improve product quality and overall performance of any machine, system or process. Asia and Europe are the two noteworthy markets for tiles, by and large representing 80.6% offer of the worldwide market in 2015. Asia Pacific (APAC) is the biggest market all inclusive, both as far as generation and utilization. According to Veljibhai Patel (President of Morbi Tile Manufacturers Association) "Selling prize of Indian tile is Rs110 in south India, the traders of Chinese tiles sell for Rs90 (This cost is 18% high than china Tile). Many researchers have done a great amount of research on productivity improvement by using industrial engineering tools and techniques in the manufacturing sector. Only a few researchers have applied productivity improvement tools in the ceramic industry. The aim of this paper is to study and co-relate the implementation, benefits, and hurdles of industrial engineering tools for productivity improvement in manufacturing industries and a possibility for successful implementation of Lean Tools in the ceramics industry.***

***Keywords: Productivity Improvement, Industrial Engineering tools, Lean Tools, Ceramics industry.***

## I. INTRODUCTION

In this era of globalization, there are several challenges facing the manufacturing sector; Complexity in taking decisions due to the arrangement and operation of machines, tools, material, people, information and randomness in the system which affects the performance of any organization (Stanley Gershwin 2000). [1]

A manufacturing system is a set of machines, transportation elements, computers, storage buffers, and other items used together for produce a value-added product, informational or service whose success and cost is characterized by measurable parameters.

Kyle B. Stone (2012) and Antony Pearce and Dirk Pons (2013) defined lean as "Getting more output with less input by implementation of lean thinking." Lean focus on elimination of all NVA (Non-Value Added Activities) in any organization and helps to reduce cost and improve product quality. [3] [2]

H&R Johnson set up the primary divider tile fabricating plant in the late 1950s at Mumbai. This was trailed by Somany Pilkington, Spartek Earthenware production, Regime Pottery, Kajaria Ceramics, Murudeshwar Ceramics, Chime Earthenware production, and numerous others. The fired tile industry can be extensively arranged into wall tile (20%), floor tile (23%), vitrified tile (50%) and industrial tile (7%) segments. [The energy and resources institute]

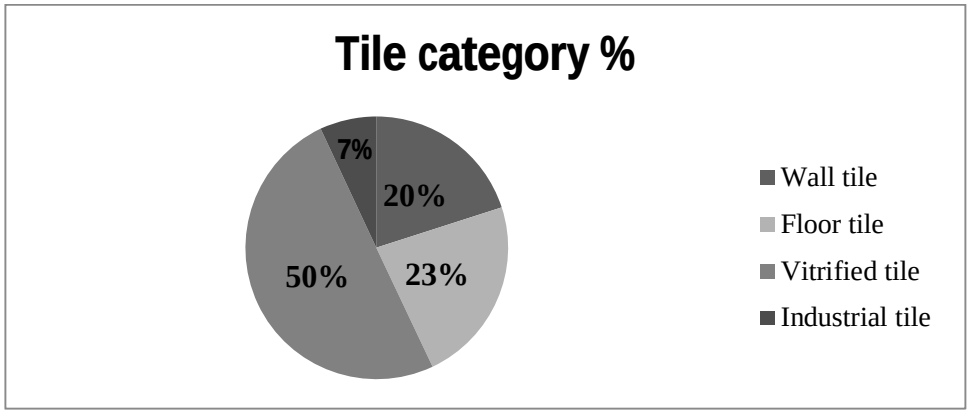


Fig.1. Applications wise Segmentation of Tiles

China was India's principle wellspring of earthenware production imports amid 2017 with imports worth Rs.25156.32 million pursued by Germany and USA with imports worth Rs.3159 million and Rs.1741 million separately. India's main five import sources together represented near 82% of India's aggregate pottery imports. China alone represented 62.1% of India's earthenware imports. The Asia Pacific represented the biggest offer in worldwide fired tiles advertise, both as far as volume and esteem. [4]

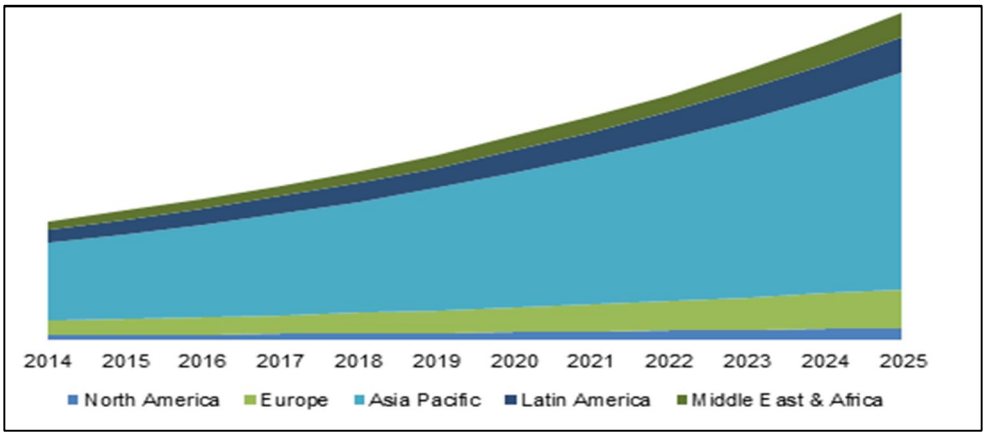


Fig. 2. Ceramic Tiles Industry, By Region (Source: - Ceramic Tiles Market Growth 2018-2025 Industry Size Analysis Report)

The further order of the clay center point as indicated by the locale is North America, Europe, Asia-Pacific (APAC), Center East and Africa, Rest of the world. Fired tiles made in the Asia Pacific 68.1% offer of the worldwide earthenware tiles showcase with CAGR of 7.19 %, Piece of the pie of China and India is most elevated in the locale. Center East and Africa is probably going to be the quickest developing area in worldwide clay tiles business. [4]

## II. LITERATURE REVIEW

Industrial engineering is concerned with the optimization of complex processes, systems, or organizations by development, improvement, and implementation of integrated systems of men, machines, money, knowledge, information, energy, and materials.[5] There is much Literature available on productivity improvement most of that follow lean tools, Lean management principles comprise of number of tools and techniques such as Kaizen, Jidoka, Poka Yoke, Visual Management, Kanban, Demand Management, Heijunka, Just in Time, Takt Time, Bottleneck Analysis, Gemba, Overall Equipment Effectiveness (OEE), Cellular Manufacturing, Continuous Improvement, Total Productive Maintenance, Total Quality Management, Root Cause Analysis, Value Stream Mapping, Continuous Flow, Lean Audit, Quick Changeover, Right First Time, 7 Wastes, Six Big Losses, SMART Goals, KPIs, 5S, SMED, A3 Problem Solving, PDCA, Standardized Work, 5 Whys, etc. A customer is willing to pay only for value added(VA) feature of the product Lean focuses on the actual needs of the customer and eliminate all non-value adding activity (NVA) such as transport, inventory, motion, waiting, over-processing, overproduction, and defects. According to some researchers that there is only around 5% of all activities are VA within operations and the remaining 95% are NVA.

### *A. 5S*

5S is a technique begun from Japan and it was first created by Hiroyuki Hirano. 5S is a simple tool and a way of organizing and managing the workspace in a clean, efficient and safe manner to enhancing the productivity, quality, and safety. 5S include five words Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize) and Shitsuke (Sustain).

1) *Sorting Out:* In this step distinguishing between necessary and unnecessary things, eliminate all unnecessary tools.
2) *Set in Order:* Everything has space and everything should be in its place. Once the unnecessary clutter (unnecessary things) has gone, you can rearrange the workspace so the right item can be picked efficiently (without waste) at the right time.
3) *Shine:* Create a plan for regular maintenance and cleaning for the workplace. Working in a clean environment improves motivation and safety.
4) *Standardize:* Turn one time efforts into habits. Make a daily 5S checklist or a chart including the schedule which indicates how frequently certain cleaning tasks must occur and a name of the responsible person.
5) *Sustain:* Once standard procedures for 5S are in place maintain and review standards.

The 5S's are composed of five easy steps to understand, which has made this technique easily accessible and implement, to many organizations. But in practice, there are certain factors such as Lack of Top Management Commitment, Financial Constraints, Lack of Awareness of 5S, Lack of Strategic Planning of 5S, Lack of Employee Commitment, Resistance to Change and Adoption, Lack

of Cooperation/Teamwork, Lack of Education and Training, Lack of Motivation that interfere with the effectiveness of the 5S technique when implemented. (Khanna and Gupta, 2014; Warwood and Knowles, 2004). [6][7]
According to researchers 5S technique effectively eliminates the weakness of the production system and strengthens the overall development of organizations in terms of safety, productivity, working culture and it builds up the continuous improvement environment. [8].

*B. KAIZEN*

Term KAIZEN is composed of two Japanese words: KAI = change, ZEN = good.
Kaizen is the organization's long-term competitive strategy, systematic approach to business improvement and an approach to creating continuous improvement.
According to Juergensen (2000), CI is a methodology that helps to enhance the quality idea to improve work culture, reduce wastage and failures of any industry. [9] According to Thomas Farrington, Jiju Antony, Kevin D O'Gorman (2017), Kaizen is a philosophy that creates improvements; these improvements can be measured as per two dimensions quality and quantity of idea. [10]
According to Carmen Jaca, Luis Paipa-Galeano, Elisabeth Viles and Ricardo Mateo (2016), to sustain and improve actions of Kaizen, routines, and habits must be developed together by designing special training programs. [11]
According to Bhuiyan & Baghel, (2005) CI is a culture of sustained improvement that focuses to achieve ongoing incremental performance and tries to improve the process and make things run smoother. [12]

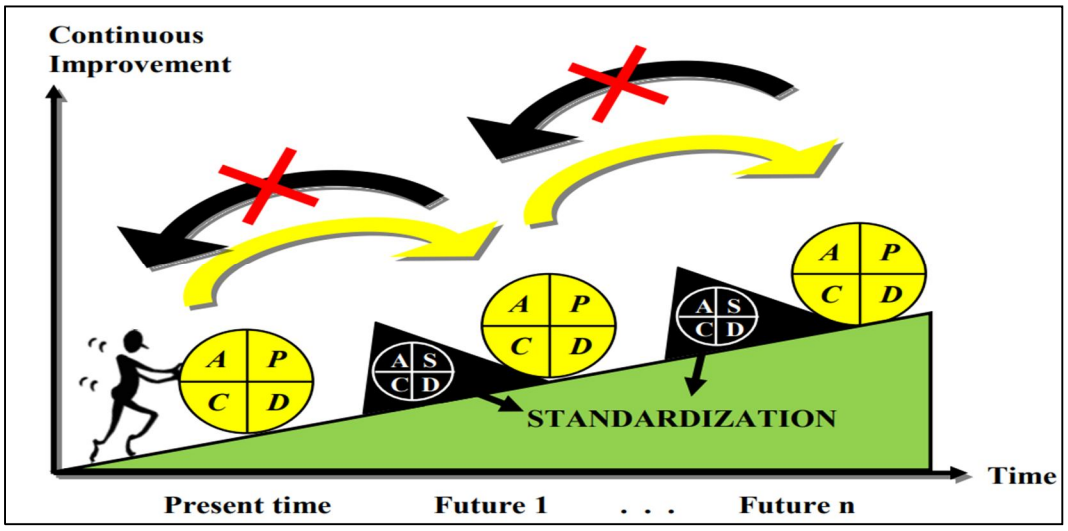


Fig. 3. The basic concept of kaizen and SDCA Cycle [15]

According to Williams (2001), Jugraj Singh Randhawa (2018), following are the major potential benefits of CI. [7] [13]

*1)* CI increases the performance of any organization;
*2)* Greater employee satisfaction;
*3)* CI increases the performance of people and improves working culture;
*4)* Improve Quality of work life of employees;
*5)* Increased productivity by eliminate waste;
*6)* CI Reduced costs;
*7)* Higher quality;
*8)* A safer work environment;
*9)* Improve teamwork.

*C. Gemba Walks*

The Gemba is a Japanese word that implies the genuine place. Where items are produced or made or where administrations are given, and so forth. It is also known as MBWA (Management by Walking Around). In lean manufacturing, the idea of Gemba is to identify wasteful activities. A Key Performance Indicators (KPIs) are a tool businesses use to measure, analyze and track the performance of any organization. The KPI equation contains some Coloured positions representing individual objects are placed on the Gemba board to provide a visual representation of all parameters. [14]

Following are the colors used on the Gemba board for data presentation.

1) Green: Green color indicates that target is achieved; all finalized parameters are under control it indicates that the process is operating at its best condition.
2) Yellow: yellow color indicates that the process is not out of control but at its upper limit make corrective actions to control it.
3) Red: Red color indicates that the process is out of control or target is not achieved.

*a) Benefits of Gemba Kaizen*

i) Increase productivity ;
ii) Reduction of setup;
iii) Reduction in lead time;
iv) Reduced Work In Process (WIP);
v) Higher employee morale, job satisfaction.[15]

*D. OEE (Overall Equipment Effectiveness)*

OEE has been widely used to determine productivity at the equipment level. It is usually formulated as a function of a number of mutually exclusive components, such as availability efficiency, performance efficiency, and quality efficiency in order to quantify various types of productivity losses, such as breakdown, set-up, adjustment, idling, minor storage, reduced speed, quality defect and rework. [16][17][18]

*1) Six Big Losses*

| Overall Equipment Effectiveness | Recommended six big losses | Traditional six big losses |
|---|---|---|
| Availability loss | Planned Downtime | Equipment failure |
| | Breakdowns | Setup and adjustment |
| Performance loss | Minor Stops | Idling and minor stops |
| | Speed Loss | Reduced Speeds |
| Quality loss | Production Rejects | Process defects |
| | Rejects on Startup | Reduced yield |
| OEE | Fully productive time | Valuable operating time |

Table 1. Six Big Losses

*2) Calculation of OEE*

[Source: - OEE made easy by Vorne]

OEE calculation is based on the three parameters: Availability, Performance, and Quality.

OEE = % of Availability X % of Performance X % of Quality

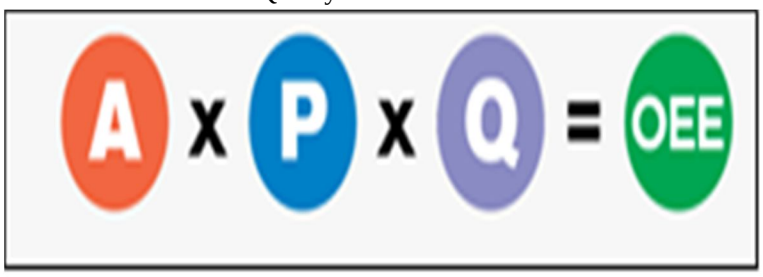


Fig.4 Calculation of OEE

*3) Availability:* Availability takes into account all events that stop planned production or as a percentage measure of the degree to which machinery and equipment are in an operable state at the point in time when it is needed.

Availability =R /P (1)

Run Time = P − S (2)

Where,

R= Run Time

P= Planned Production Time

S= Stop Time

4) *Performance:* The performance considers whatever makes the framework keep running at not as much as its greatest planned speed. It is the ratio of Actual production time to Available time.

Performance = (Ideal Cycle Time x Parts Produced) / Available time (3)

Ideal Cycle Time is the least time to complete a single unit. Performance can also be calculated as:

Performance = (Total production / Total Production Time) / Ideal Production Rate (4)

5) *Quality:* Quality takes into account manufactured good production as a percentage of the total production.

Quality is calculated as:

Quality = Defect-free production / Total production (5)

OEE is calculated as:

OEE = % of Availability X % of Performance X % of Quality (6)

*E. Root Cause Analysis (RCA)*

Root Cause Analysis is a systematic and efficient procedure used to distinguish the underlying drivers of issues. Issues can best be illuminated by redressing their main drivers through remedial activities; it can effectively take care of issues in a convenient way. [19]

1) *Steps For Root Cause Analysis*

*a)* Define the Problem
*b)* Understand the Problem
*c)* Immediate Action
*d)* Corrective Action
*e)* Confirm the Solution

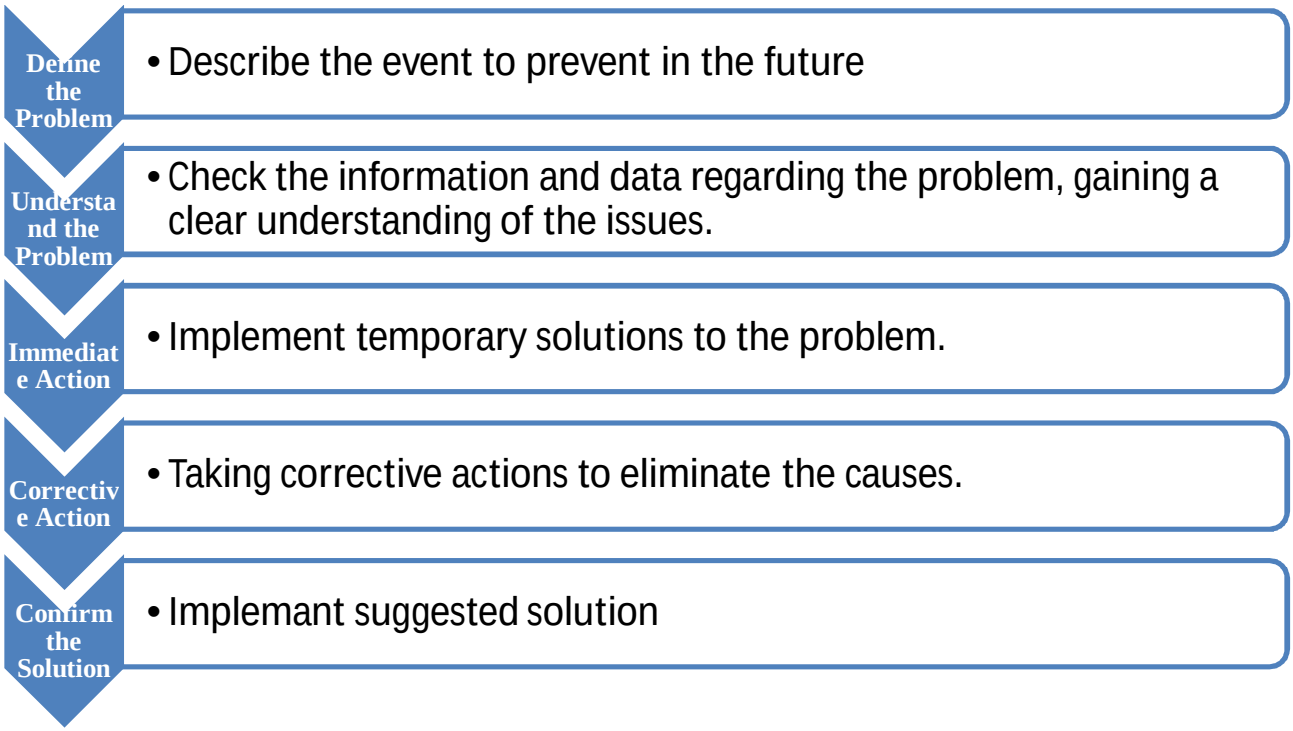


Fig.5 Steps of RCA for problem-solving

2) *Tools for Root Cause Analysis [20]*

*a)* 5 Why
*b)* Fishbone Diagram
*c)* Histogram
*d)* Fault tree analysis
*e)* Affinity diagrams
*f)* Interrelationship diagram

*F. Plan-Do-Check-Act (PDCA) Cycle*

PDCA cycle sometimes called PDSA, the "Deming Wheel," or "Deming Cycle," is one of the simplest and the easiest management approaches for problem-solving, process control and continuous improvement also help to sustain improvement.

The four phases are

1) *Plan Step:* Identify and analyze the problem or opportunity and establish the objectives and goals of the task to be improved or developed.
2) *Do Step:* Test the potential actions as per plan and perform all the tasks as per the implementation plan.
3) *Check (Study) Step:* Study the result, measure effectiveness and validate the outcome; and establish that action as a new standard.
4) *Act Step:* Correct the defects and make it comply with the specifications if the solution was successful, implement it. [21]

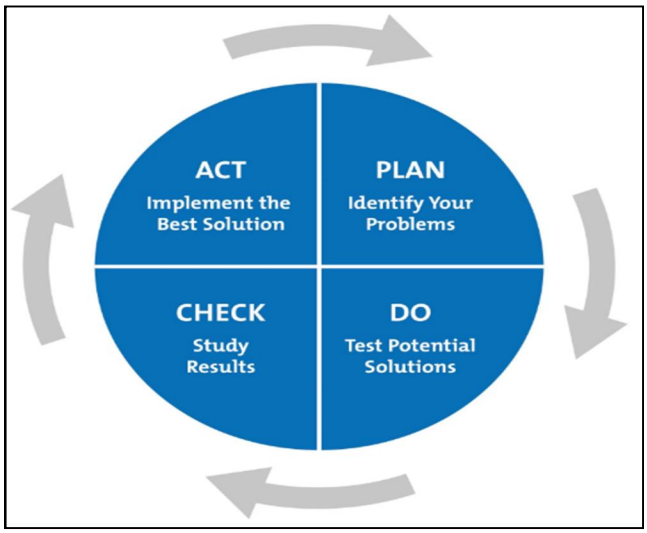


Fig. 6. The framework of the PDCA cycle

## III. FUTURE SCOPE AND RESEARCH GAP

China with 40 percent piece of the pie positions first in the worldwide ceramic market pursued by India which at present adds to 12.9 percent of the worldwide earthenware utilization bringing about Rs. 250 billion of incomes. Indian artistic industry is hoping to twofold its turnover to Rs. 500 billion by 2020 and plans to end up a worldwide pioneer in up and coming years. [22] Many researchers have done a great amount of research on productivity improvement by using industrial engineering tools and techniques in the manufacturing sector. Only a few researchers have applied productivity improvement tools in the ceramic industry here researcher can find many industrial engineering tools to improve productivity in the ceramic industry.

## IV. CONCLUSION

This article has presented the use of different IE(Industrial Engineering) tools for productivity improvement of manufacturing sectors, Among all IE(Industrial Engineering) tools LEAN tools are most effective and efficient tools for productivity improvement of any manufacturing sector. According to Rakesh Kumar, Dr.Vikas Kumar (2014) and Roger Gill (2003) Barriers to Lean can be identified as Lack of top management commitment and support, Lack of skill, training and education of employee, Misunderstanding of Lean, Employees' resistance to change, Low morale and job dissatisfactions, facility planning and layout, Communication gap, Working cultural etc. [24] [23] Ceramic tiles manufacturing is a very complex and nature sensitive process so it is difficult to implement all IE tools in ceramic industry, Some tools like (5S, KAIZEN, Gemba Walk, OEE, SMED,PDCA, 7 Wastage and VSM) are most effective tools for productivity improvement in ceramics and also easy to implement. Some tool like the use of six sigma is very difficult in the ceramic process but it can be applied at the selected operation of a process like,

*A.* Printing operation,
*B.* Press operations,
*C.* Packaging,
*D.* Ware House.

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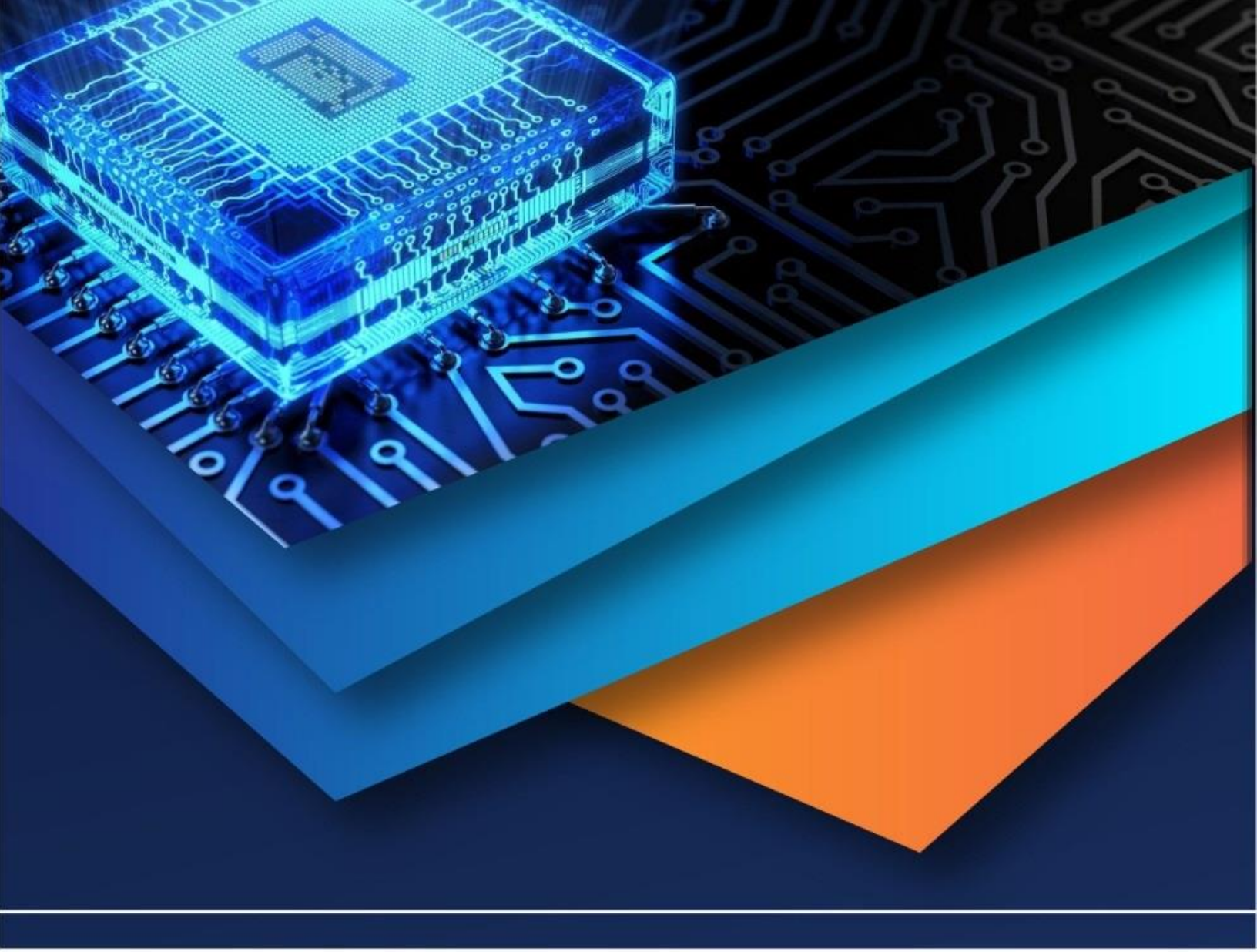

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