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Reduction of Non-Value-Added Activities in An Aerospace Industry Using Value Stream Mapping and Time Study

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Abstract: ***The industry was having lesser productivity than the required due to the presence of certain 'non-value added' activities. Hence, the requirement was to improve productivity by means of cost reduction and rationalisation of manpower. Since the main purpose was to eliminate any process that does not add value to the final output. To reduce the waste, the lean manufacturing is the best choice among the available techniques. The Value Stream Mapping (VSM) is one of the major components in lean manufacturing techniques.***
This helps in identifying the major opportunities for performance improvement in the assembly line of the aerospace industry. The Value Stream Mapping was developed in the required assembly lines of the aerospace industry. The Value Stream Mapping was used for other techniques like Time-Study, 5s implementation and skill based line balancing at the required workstations. Time-Study was conducted at the bottleneck workstations.
The results were analysed by categorising them as value added (VA) and non-value added (NVA) components. This has benefited in identifying waste in the assembly line. The activities which were not adding value to the final product were eliminated and compared with previous results.
Keywords: Value Stream Mapping, Lean manufacturing, Time-Study, 5s, Productivity.

I. INTRODUCTION

In the present day competitive market environment, a company's survival is determined by how well it serves its consumers in terms of providing high-quality products at an affordable price. Product quality is determined by the various aspects such as operation characteristics, reliability and customer satisfaction. Under this circumstances, the value for money paid as the price for the component has become a critical parameter. This calls for continuously synchronizing the value adding aspects to the product development environment.

A. About Lean Manufacturing

In any process there is always a chance to improve endlessly. Similarly, in the aerospace industry, the non-value added activities were present and the main aim of lean manufacturing was to eliminate such non-value added activities. The lean manufacturing is one of the most suitable technique for this purpose. Lean Manufacturing is an operational strategy aimed at getting the least possible cycle time by eliminating waste. The main goal is to maximise value-added work by minimising waste and eliminating incidental work. However, lean tools was later evolved in response to the changing and competitive business environment. Many authors believe that lean manufacturing is a waste reduction approach, but in practice, lean manufacturing maximises the value of the product through waste minimization. The value of the products/services as seen by the client is defined by lean principles, and then the flow is created.

B. About Value Stream Mapping (VSM)

Many businesses make use of the VSM tool. VSM is a graphical representation of material and information flow in manufacturing systems. The map depicts all of the tasks involved in the process, beginning with the acquisition of raw materials and ending with the delivery of finished goods to the consumer. This study enables the identification of all types of waste and the planning of subsequent actions to eradicate them.

C. About Work Study

Work study is a technique for increasing a company's production efficiency (productivity) by eliminating waste and redundant procedures. It's a method for identifying non-value-adding actions by looking into all the variables that influence the job. It's the only method for establishing time standards that is both accurate and systematic.

II. LITERATURE REVIEW

The following published articles were referred to in the course of completing the present research study.

A. Literature Articles about Lean Manufacturing

Vidhate Teja and Ashwini salunke [2018], stated that the necessary lean techniques that are supremely used in the construction industry are VSM, Pull system, JIT, Kanban, 5S and Last Planner System (LPS) [1].

Devarani Devi et al [2013] investigated the adoption of lean manufacturing methodologies in the Indian electronics manufacturing industry, identifying JIT (Just in Time), Six Sigma, Jidoka, and Kaizen as the most extensively utilised lean manufacturing technologies [2].

Abhishek Kumar Singh et al [3] employed an information system in conjunction with lean manufacturing to decrease waste in the process sector, opting to apply lean tools (VSM, TPM, Pull system, Kanban, SMED, and production levelling) to shorten lead times.

B. Literature Articles about Value Stream Mapping

Hariram VR and V. Muthukumaran [2017] used VSM to detect non-value added time in the auto component sector and executed a layout adjustment to boost efficiency. Another lean implementation modified the plant architecture and enhanced OEE [4].

Subashini et al [2012], employed VSM as a major tool in a kitchenware manufacturing industry because it detects wastes throughout the value chain and paves the path for the identification of improvement areas, which results to a reduction in lead time and Work in Progress Inventory [5].

C. Literature Articles about Time Study

A. Sai Nishanth Reddy, P. Srinath Rao and Rajyalakshmi G. [2016], used time study for productivity improvement in small scale solar appliances industry [6].

III.METHODOLOGY

The procedure was carried out by collecting data from different inquiries with shop floor experts and participating personally in the measurement of time spent on various procedures.

A. Collecting Data

First, acquiring data directly from the shop floor of the assembly area. To do this, relevant discussions were held with the concerned authorities of the plant. All the required data were collected in order to identify the locations where improvements can be effected.

B. Analysing Data

The data and information that had been compiled had been discussed with heads of different departments. The objective of this analysis is to reduce lead times and increase throughput. The current state Value Stream Map had been drawn based on the data and information compiled.

C. Identifying the required improvements

This will enable us to spot the problem areas and thus evolve the means to improve the work flow, efficiency, reliability, and flexibility of the process. Based on a comparison between cycle time and takt time we define the bottleneck work stations which were becoming critical.

D. Work Study at critical workstations

The observations were made at 5 minute intervals which were recorded with respect to activities that were performed. These were further analysed by categorising them into value-added (VA) and Non-Value Added (NVA) activities. This forms the basis for productivity improvement.

E. Effecting the changes for improvement

Based on the above analysis, pull system has been adopted for eliminating inventory build-up through, the transition from 'build to stock' to 'made to order'. This had resulted in a significant improvement in productivity.

IV. VALUE STREAM MAPPING AND TIME STUDY

A. Creation of Value Stream Map

Among all the sections of the assembly line, the critical path was chosen for value stream mapping. This section had more number of workstations, SOPs and manpower.

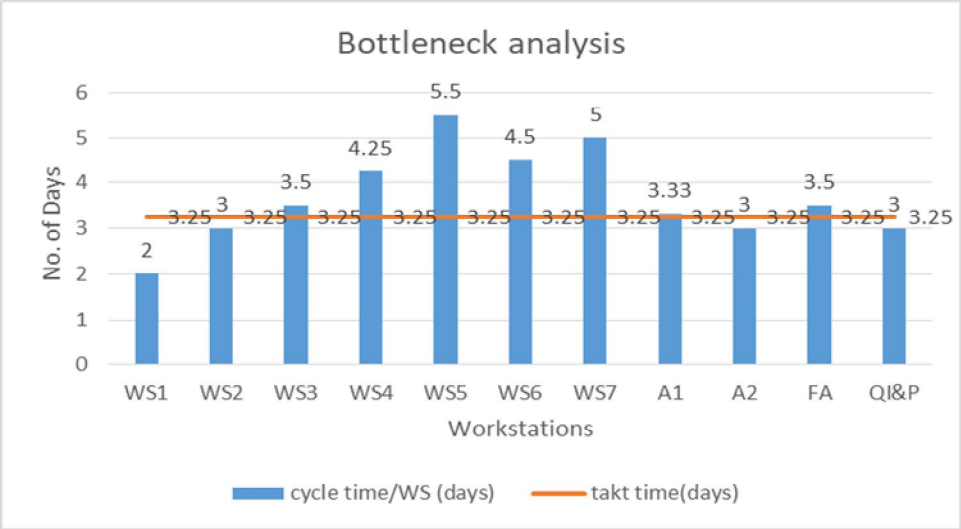
Data obtained from the Value Stream Map:

The total lead time for the process = 92 days.
Value Added time = 78.5 days
Non-Value Added time = 13.5 days

Here, the takt time of the assembly line is calculated as the time available divided by customer requirement.

Takt time = 26/8 = 3.25 (available time is 26 days since the working days of a month are taken as 26).

The work stations in the critical path which were having more cycle time than takt time are identified as bottlenecks.



Graph.1 Bottleneck analysis of critical path

The Time Study was planned to perform at workstation-5 due to its large cycle time. The Time-Study used to identify the Value-Added and Non-Value Added activities.

B. Time Study observations

The Time Study was conducted at workstations to identify the VA and NVA activities.

After time study, we had segregated percentage of VA and NVA activities as follows.

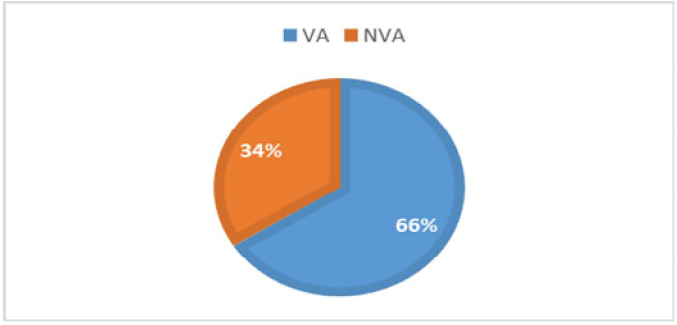


Chart.1 VA-NVA bifurcation before implementation of actions plans

1) *First Step:* As the process of VSM, first step is to make the VA as fast as possible. In that regard it should concentrate on VA activities. The majority VA activities are drilling and riveting. Some of those problems and their proposed action plans are as follows:

Table1. Respective action plans for problems in Value Added activities

Problem	Action Plan
While drilling, finding the tool as per requirement became difficult. Since non-availability of tools, less sized drill bits were using more number of times thus it takes lot of time.	Proposed shadow boxes with tool names, so that employees doesn't get confuse. Also non-availability of tools problem was taken to the higher administration.
Unskilled workers were not used to work and taking so much time.	Proper training was proposed to the required employees. And this problem had addressed to the respective supervisors.
While riveting, two workers were doing the work and talking while riveting which was unproductive time.	The proper supervision was lacking, so the problem was deployed to the concerned superiors.

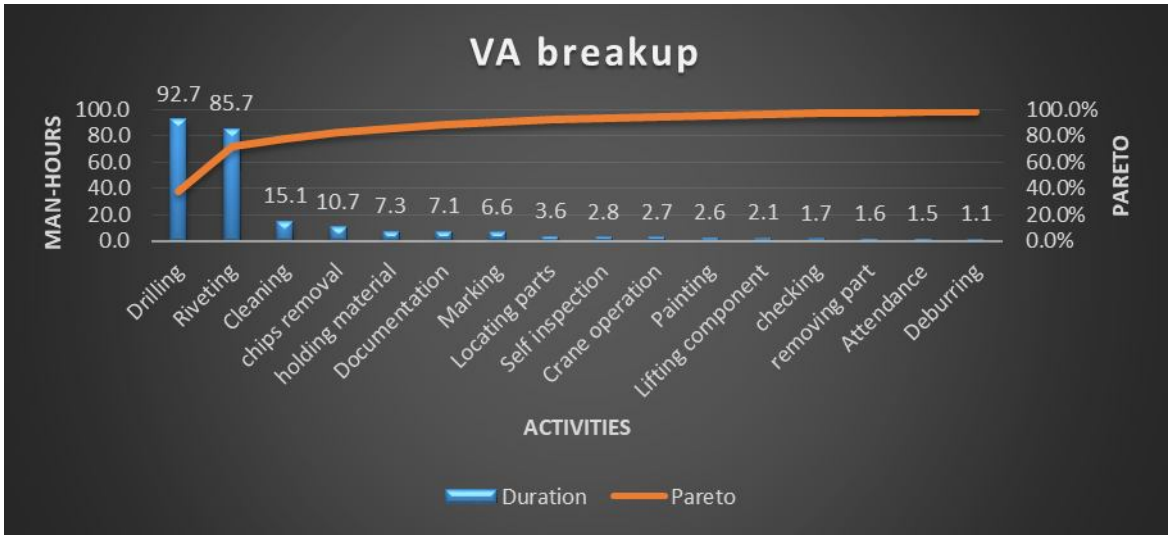


Chart.2 Value Added activities breakup before action plans

2) *Second Step:* In VSM, second step is to nullify the NVA activities. The problems and proposed solutions were as follows.

Table.2 Respective action plans for problems in Non-Value Added activities

Problem	Action Plan
Tool searching, this NVA was of two types, non-availability of tools and not-following 5s.	The insufficiency of tools will be addressed to the particular concerned For maximum efficiency of desired area, 5s was implemented.
Unnecessary discussions, the employees were in discussions which doesn't add value to the work.	The supervisors at particular work station were suggested to keep an eye on the employees.
Waiting for approval from superiors to proceed, the workers were idle till the approval was given	The authority should be given to some of the experienced and skilled employees, so that they didn't need to wait for approval.

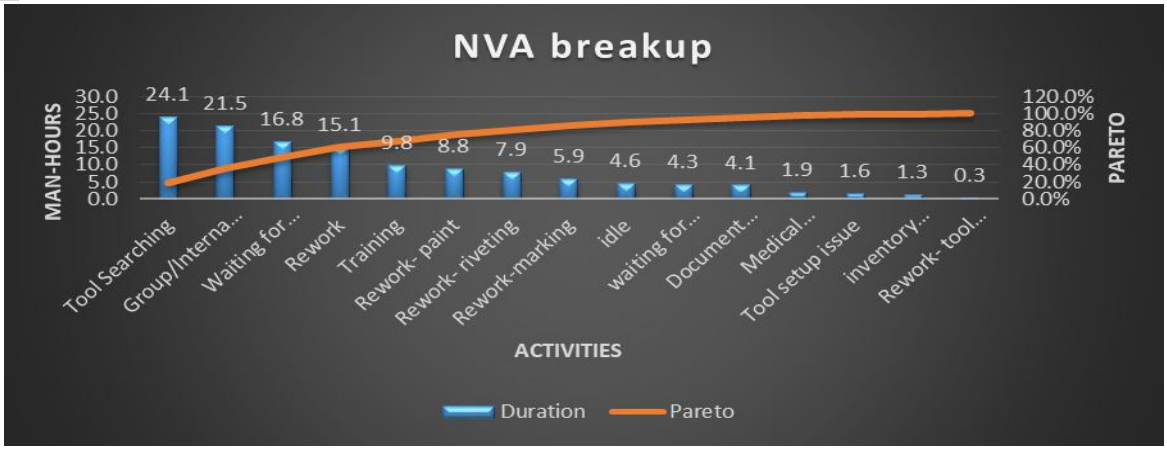


Chart.3 Non-Value activities breakup before implementation of plans

The skill-based line balancing, this is about line balancing using operator skill efficiency that taking data of all the operators working at workstation about their previous working capacity and their primary working ability.
The 5s technique also used for clean and tidy environment in the workspace.

C. Time Study after implementation

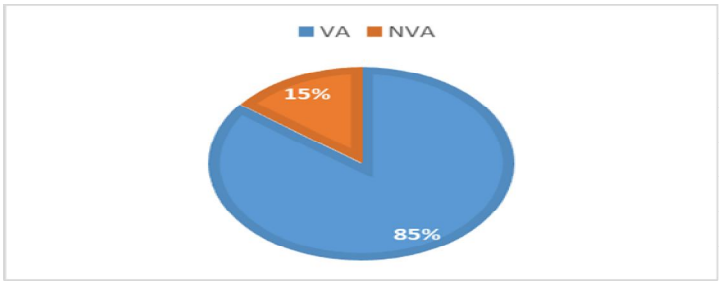


Chart.4 VA-NVA bifurcation after implementation of action plans

As observed during time study of workstation-5, the NVA was reduced as a result of actions were taken. The reduced NVA can be seen numerically and graphs as follows.

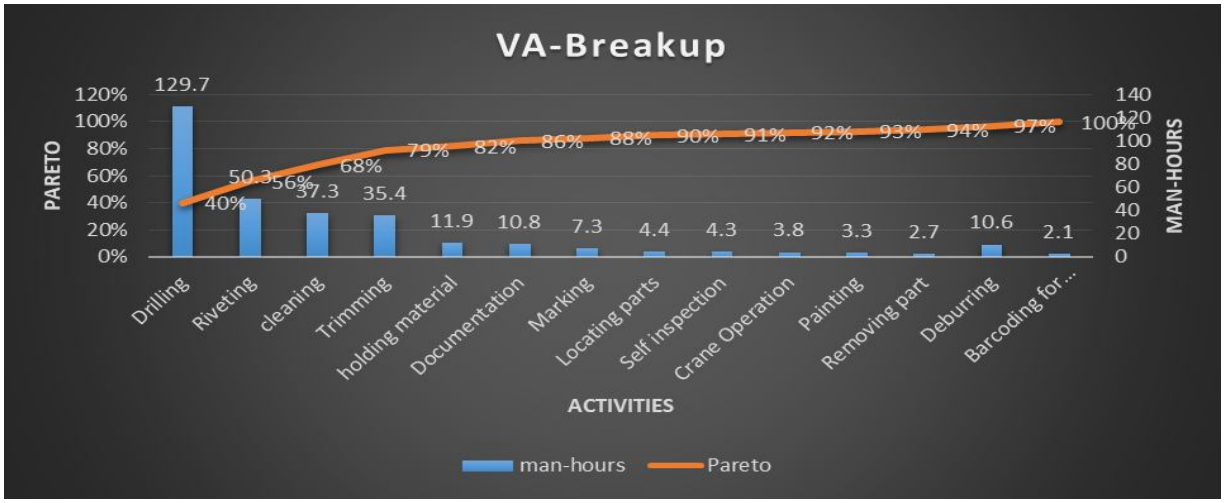


Chart.5 Value-Added activities breakup after implementation of action plans

Referring to the Chart.5 and Chart.6, it can clearly observe that VA-NVA reduced noticeably as compared with previous time-study. The cycle time had come down drastically by the result of action plans implemented at workstation.

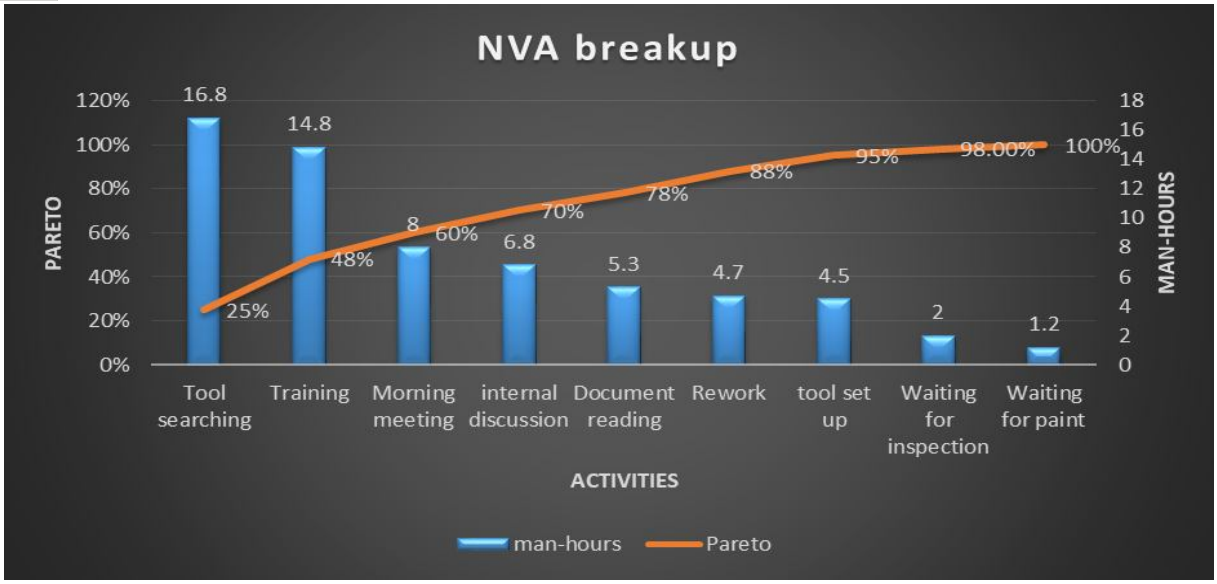


Chart.6 Non-Value Added activities breakup after implementation of action plans

D. Output of time-study analysis

Cycle time of the workstation before conducting time study was 5.5 days. The problems and different causes were identified at the workstation. After implementing the action plans, the Non-Value added activities were reduced noticeably, also the time for VA activities were reduced. From the above graphs the difference could be easily identified.

The total cycle time of the workstation after conducting Time Study was 4 days. The percentage of amount of time reduction was, 27.7%.

V. RESULTS AND DISCUSSIONS

The takt time of the assembly line is calculated as the time available divided by customer requirement.

Takt time = 26/8 = 3.25 (time is 26 days since the working days of a month are taken as 26.

Cycle time of the workstation before conducting time study was 5.5 days. Cycle time of the workstation-5 after implementing different methods and other methodologies was 4. The percentage of reduction in cycle time of workstation was 27.3%.

The percentage of time spent on activities that has been reduced,

Analysis	Before Time Study	After Time Study	Decreased time (%)
Total cycle time	5.5 Days	4 Days	-27.7%
Tool Searching	24.1 Man-hours	16.8 Man-hours	-30%
Internal Discussion	21.5 Man-hours	6.8 Man-hours	-67.6%
Rework	15.1 Man-hours	4.7 Man-hours	-68.8%
Waiting for Quality	16.8 Man-hours	2 Man-hours	-88%
Drilling	92.7 Man-hours	129 Man-hours	-23%
Riveting	85.7 Man-hours	50.3 Man-hours	-14.9%
Cleaning	15.1 Man-hours	37.3 Man-hours	-5%
Painting	2.6 Man-hours	3.3 Man-hours	-3%

Table3. Percentage of time reduced with respect to different activities

The percentage of time reduced with respect to activities,

1) *NVA Activities*

Tool searching: 30%
Internal discussions: 67.6%
Rework: 68.8%
Waiting for Quality: 53.2%

2) *VA Activities*

Drilling: 6%
Riveting: 14.9%
Cleaning: 5%
Painting: 3%

The value is added when customer satisfied with the output. The customer demand was to achieve 8 aircraft per month, when we achieve it then the reliability on the firm would increase and that will eventually increase the good will of the company.

VI. CONCLUSIONS

There is always scope for improvement in the work area for better production. The cycle time had come down from 5.5 days to the 4 days with various improvement techniques. Similarly there is scope for better improvement again, it is a continuous process till achieving zero wastage. The other benefits resulting from the adoption of Lean manufacturing were the creation of a clean and tidy work area. This will make life hassle-free for the workers by facilitating easier access to the right tools, material and other required things. With the adoption of Lean techniques in the work area, the workers will get more focused on the main task instead of wasting time on unnecessary jobs like searching for tools and interpreting unclear instructions. This would result in high quality work along with the cost reduction.

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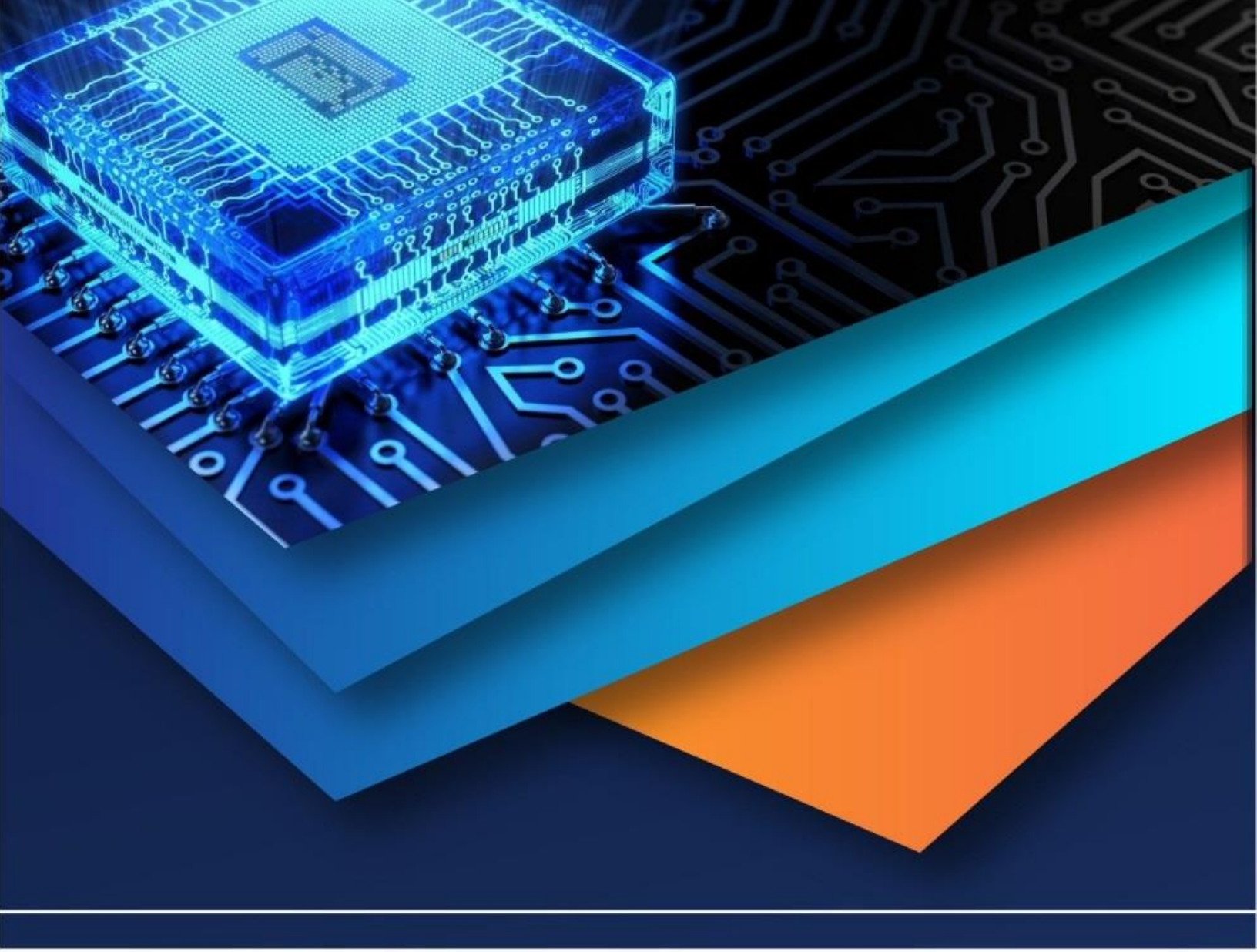

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