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# Implementation of OEE in a Paranjape Agro Industry to Improve Productivity

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***Abstract:*** ***Total Productive Maintenance (TPM) is a method that aims to ease further capital investment by enhancing availability of current equipment. Overall Equipment Effectiveness (OEE) is a tool that is use by manufacturing industries to improve performance in their field. Using OEE metrics, reports and instrument panel, your management side will identify that production are going to satisfy consumer orders.***

***In order to satisfy consumer demands, efforts can be rapidly focused on fixing problem in any area. OEE will enhance from resources, both people and equipment.***

***It helps industries to get the most out of their business and helps improve bottom line profitability. OEE gives a steady measurement to support enhancement and cost-effectiveness since it gives a whole picture of the equipment's health, displays the equipment operations that adds value, gives precise unbiased snapshots which openly shares information and OEE promotes no-blame approach in issues related to handling equipment. OEE displays the definite performance of a tool relative to its performance.***

***Capabilities of OEE looks at the entire manufacturing environment measuring the equipment availability, the production efficiency while the equipment is available to run product, as well as the efficiency loss that results from scrap, rework and yield losses.***

***This project reviews OEE of RCN sorting and cutting machine in agro industry. This OEE tool is a route map to improve the effectiveness of manufacturing process and equipment (i.e. loading time, job setting, machining, machine utilization, etc.) Current situation and all time rises question for any company is how to optimize the performance of their existing machines and equipment.***

***The answer of OEE which extricate all the reason for delay in the job. OEE measures inefficiency and also categorizes those into three factors for better understanding of manufacturing procedure. In this project, we carried out OEE on RCN sorting and cutting machine to identify bottleneck and hidden losses. So, through the case study of implementing OEE in an agro industry (cashew processing industry), the increase on productivity are discusses. On the basis of results database has been prepare which can be further used in any agro industry.***

***Keywords: Availability, Downtime, OEE, Productivity and TPM.***

## I. INTRODUCTION

TPM is model that was introduce by Nakajima in 1180s, that offers a measurable method called overall equipment effectiveness(OEE) for determining productivity of specific equipment in factory. Losses of essential features of manufacturing are recognize and measure by OEE.

The goal of TPM (Total Productive Maintenance) is to raise the availability of present equipment. Hence need for additional capital investment is decrease.

The crucial metric of TPM is OEE (Overall Equipment Effectiveness). The definite performance of a tool is monitored by OEE compared to its performance. OEE measures the equipment availability also, the efficiency of production when the equipment is available for production, and efficiency loss that results from scrap, rework and yield losses in whole manufacturing environment. This paper analyses the OEE of RCN sorting and cutting machine in agro industry.

The effectiveness of equipment and manufacturing method is guided by OEE. Current scenario and the problem raised by any industry is how they can improve the performance of their tools and existing machines. For better understanding of manufacturing method the OEE has been categorize into three categories which also measures inefficiency. In this paper, we carried out OEE on RCN sorting and cutting machine to bottleneck and hidden losses.

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*A. Six big losses*

These are categorised as below

TABLE I
Six Big Losses

| Sr. No. | Six big loss category | OEE loss category | Event examples | Comment |
|---|---|---|---|---|
| 1 | Breakdowns | Down Time Loss | Tooling Let downs<br>Accidental Maintenance<br>Overall Breakdowns<br>Tool Failure | There is flexibility on where to fix the threshold among a Minor Stop (Speed Loss) and Breakdown (Down Time Loss). |
| 2 | Setup and Adjustments | Down Time Loss | Setup/Changeover<br>Material Scarcity<br>Operator Absences<br>Major Modifications<br>Warm-Up Time | The setup time reduction agenda is often addressed by this loss |
| 3 | Small Stops | Speed Loss | Blocked Product Flow<br>Element Jams<br>Misdeeds<br>Sensor Blocked<br>Delivery Blocked<br>Cleaning/Examine | This normally consists of stops that are below five minutes and that do not need maintenance staffs. |
| 4 | Reduced Speed | Speed Loss | Uneven Running<br>Below Nameplate Capacity<br>Below Design Capacity<br>Tool/Equipment Wear<br>Worker Inefficiency | Whatever that retains the process from running at its notional determine/maximum speed (a.k.a. Ideal Run Rate or Nameplate Ability). |
| 5 | Start-up Rejects | Quality Loss | Scrap<br>Rework<br>In Process Destruction<br>In-Process Termination<br>Improper Assembly | Discards through warm-up, start up or other initial production. This can be due to incorrect setup, warm-up period, etc. |
| 6 | Production Rejects | Quality Loss | Scrap Rework<br>In-Process Destruction<br>In-Process Termination<br>Improper Assembly | Discards for the period of fixed-state production. |

## II. METHODOLOGY

*A. Steps in OEE*

1) *Availability:* It takes into account Down Time Loss, which includes any Events that stop planned production for an appreciable length of time (usually several minutes – long enough to log as a tractable Event).

Availability is calculated as:

$$\text{AVAILABILIITY} = \frac{\text{ACTUAL OPERATING TIME}}{\text{PLANNED OPERATING TIME}} \times 100$$

From Plant Operating Time, we subtract Planned Shut Down, which includes all events that should be excluded from efficiency analysis because there is no intention of running production (e.g. breaks, scheduled maintenance, periods where there is nothing to produce). The remaining time is planned production Time.

2) *Performance:* It takes into account Speed Loss, which includes any factors that cause the process to operate at less than the maximum possible speed, when running.

Performance is calculated as:

$$\text{PERFORMANCE} = \frac{\text{QUANTITY MADE}}{\text{THEORETICAL QUANTITY}} \times 100$$

Performance takes into account Speed Loss, which includes all factors that cause your process to operate at less than the maximum possible speed when running. Examples include machine wear, substandard materials, misfeeds, and operator inefficiency. The remaining time is called Net Operating Time. Performance is the ratio of Net Operating Time to Operating Time.

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3) *Quality:* It takes into account Quality Loss, which accounts for produced pieces that do not meet quality standards, including pieces that require rework Quality is calculated as:

$$\text{QUALITY} = \frac{\text{QUANTITY OF GOOD PRODUCT}}{\text{TOTAL QUANTITY MADE}} \times 100$$

4) *OEE factors:* It introduces Availability, Performance, and Quality the metrics that you will use to measure your plant's efficiency and effectiveness

OEE takes into account all three OEE Factors, and is calculated as:

$$\text{OEE} = \text{AVAILABILITY} \times \text{PERFORMANCE} \times \text{QUALITR}$$

*B. World class OEE*

Basically the OEE is given as the ratio of Complete Productive Time to Planned Production Time. Practically Overall Equipment Effectiveness is considered as the product of its three contributing factors:

$$OEE = AVAILABILITY \times PERFORMANCE \times QUALITRY$$

OEE becomes a simple test due to this type of calculation. For example, if all three factors of OEE (availability, performance and quality) are 95.0%, the OEE would be 85.73%. Practically, accepted World Class goals for every factor are somewhat different from each other; it is shown in the table below.

TABLE II World Class Oee

| OEE FACTOR | WORLD CLASS |
|---|---|
| Availability | 90.0% |
| Performance | 95.0% |
| Quality | 99.9% |
| OEE | 85.0% |

## III. CASE STUDY

(Paranjape Agro Products (India) Pvt Ltd)

*A. Introduction*

Initially M/s. Paranjape Agro Products (India) Private Limited (PAPIPL) was established in 2010 with trading intentions i.e. buying and selling of agro products mainly cashews. M/s. Paranjape Cashew Products (PCP) which is a sister concern and owned by Mrs Samruddhi Paranjape (Chairperson and co-founder of PAPIPL) was in cashew processing from June 2011 with daily processing capacity of 1 Ton. She also received women entrepreneur award for 2013 (Maharashtra & Goa states combined) by Sakal newspaper and MITCON. Due to overwhelming response of customers, it was unanimously decided by management to enter into cashew processing at large scale. So M/s. PAPIPL has set up a cashew processing plant of 10 tons in Ratnagiri.

*B. Overview of cashew nut processing*

1) *Drying:* In this process the raw cashew nut are sun dried for 24 hours and in monsoon season it is air dried
2) *Sorting:* This process take place after drying is completed. Here the raw cashew nuts are sorted according grades A, B, C1, C2 and D as per size in descending order. In the RCN sorting machine the feeding of cashew nut in RCN sorting machine is by the hopper the capacity of RCN sorting machine is 600 kg/ hr.
3) *Boiling:* After sorting this cashew nuts are boiled for 12 to 14 minutes as per moisture contain according to grades, There are 3 boilers having capacity of 320 kg each.
4) *Drying:* When the cashew nuts are boiled they are air dried for 12 hours.
5) *Shelling:* In shelling process, the nuts are deshelled by cutting m/c or by hand in some cases. There are 10 machines with 2 cutter each and 2 high capacity machines with 8 cutters each. There are customized 2 machines which cuts the cashews of grades A, B and C, D
6) *Drying:* The kernels are dried in the tray dryer to remove the tanning and moisture content inside the kernel. Drying also help in easy peeling of red/ brown skin the kernel should be dried for 8 hours at 65°c.
7) *Moisturising:* In the process of moisturizing, the cashew nuts are kept in moisturizing room for 3-4 hours to maintain moisture
8) *Peeling:* The process of removing red/brown skin (Testa) present on the kernel by hand or by automatic machine is called peeling*:*
9) *Grading of Cashew Kernel:* The peeled cashews are graded on the basis of shape, size and colour.

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10) *Packaging:* Before packing, the graded kernel should be dried again for 1 hour to remove the little amount of moisture again during peeling, and grading process .The kernel are filled in tin and packed.

*C. Calculation of OEE*

*1) Conventional Method*

Table III Formula For Sorting And Cutting Machine

| Formulas |
|---|
| Plant operating time = Shift length × No. of shifts |
| Planned production time = Plant operating time – Machine ideal time – Planned maintenance |
| Total downtime = Minor stoppages + Unplanned maintenance + setup and change over time |

Table IV Worksheet Of Oee For Sorting Machine

| Overall Equipment Effectiveness Worksheet | | | | | | |
|---|---|---|---|---|---|---|
| Machine:- RCN Sorting Machine | | | | | | OEE |
| OEE Data | | | | | | |
| AVAILABILITY | | | | | | |
| No. of Shifts | 1 | | | | | |
| Shift duration | 8 hours shift (8 AM to 4 PM) | | | | | |
| Shift length | 480 | | Minute per shift | | | |
| Short breaks | 22 | Breaks@ | 115 | Min each | 30 | Minutes |
| Meal breaks | 11 | Break@ | 330 | Min each | 30 | Minutes |
| Machine ideal time | 120 | Minutes | | | | |
| Minor stoppage | 10 | Minutes | | | | |
| Planned maintenance | 20 | Minutes | | | | |
| Unplanned maintenance | 10 | Minutes | | | | |
| Planned production time | 2280 | Minutes | | | | |
| Actual operating time | 2260 | Minutes | | | | |
| PERFORMANCE | | | | | | |
| Sample quantity | 50 kg | Sorting time | 7 minutes | | | |
| Actual quantity made | 429 kg | Sorting time | 60 minutes | | | |
| Theoretical quantity made | 600 kg | Sorting time | 60 minutes | | | |
| QUANTITY | | | | | | |
| For sample of 50 kg of 'C' grade | | | | | | |
| Whole cashew | 12.50 kg | | | | | |
| Pieces | 0.708 kg | | | | | |
| Uncut | 1.488 kg | | | | | |
| Manual rework | 0.564 kg | | | | | |
| Shells | 34.74 kg | | | | | |
| Total quantity made | 15.26 kg | | | | | |
| Good quantity | 12.50 kg | | | | | |

| OEE calculations | | | |
|---|---|---|---|
| OEE factors | Calculations | OEE | OEE % |
| Availability | Actual operating time/Planned operating time | 0.9285 | 92.85% |
| Performance | Quantity made/Theoretical quantity | 0.7150 | 71.50% |
| Quality | Quantity of good products/Total quantity made | 0.8191 | 81.91% |
| Overall OEE | Availability × Performance × Quality | 0.5290 | 52.90% |

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TABLE V
Worksheet Of Oee For Cutting Machine

| Overall Equipment Effectiveness Worksheet | | | | | | |
|---|---|---|---|---|---|---|
| Machine:- RCN Cutting Machine | | | | | | OEE |
| OEE Data | | | | | | |
| AVAILABILITY | | | | | | |
| No. of shifts | 1 | | | | | |
| Shift duration | 8 hours shift (8 AM to 4 PM) | | | | | |
| Shift length | 480 | | Minute per shift | | | |
| Short breaks | 2 | Breaks@ | 115 | Min each | 30 | Minutes |
| Meal breaks | 1 | Break@ | 330 | Min each | 30 | Minutes |
| Minor stoppage | 10 | Minutes | | | | |
| Set up and changeover time | 10 | Minutes | | | | |
| Planned maintenance | 20 | Minutes | | | | |
| Unplanned maintenance | 10 | Minutes | | | | |
| Planned production time | 360 | Minutes | | | | |
| Actual operating time | 320 | Minutes | | | | |
| PERFORMANCE | | | | | | |
| Sample quantity | 5 kg | Cutting time | 5 minutes | | | |
| Actual quantity made | 60 kg | Cutting time | 60 minutes | | | |
| Theoretical quantity made | 100 kg | Cutting time | 60 minutes | | | |
| QUANTITY | | | | | | |
| For sample of 50 kg of ‘C’ grade | | | | | | |
| Whole cashew | 12.50 kg | | | | | |
| Pieces | 0.708 kg | | | | | |
| Uncut | 1.488 kg | | | | | |
| Manual rework | 0.564 kg | | | | | |
| Shells | 34.74 kg | | | | | |
| Total quantity made | 15.26 kg | | | | | |
| Good quantity | 12.50 kg | | | | | |

| **OEE calculations** | | | |
|---|---|---|---|
| **OEE factors** | **Calculations** | **OEE** | **OEE %** |
| Availability | Actual operating time/Planned operating time | 0.8888 | 88.88% |
| Performance | Quantity made/Theoretical quantity | 0.600 | 60.0% |
| Quality | Quantity of good products/Total quantity made | 0.8191 | 81.91% |
| Overall OEE | Availability × Performance × Quality | 0.4212 | 42.12% |

*D. Identification of problem*

From above calculation the availability of sorting machine is 93.75%, performance is 71.5% and quality is 81.9% and that of cutting machine is 88%, 60% and 81% respectively. The OEE of cutting machine is 42%, and that of sorting machine is 52%.The sorting is not performed properly as there is no uniform feeding in the hopper and different grade cashew nuts get mixed with each other (C1 and C2 grade and B and C1 grade). Here there are different machines available for shelling of cashew nuts (A, B cutting machine and C, D cutting machine), on A and B cutting machine, cashew grades of only A and B are shelled and on C and D machine, cashew grade of C and D are shelled .if the operator tries to adjust the cutter of the cutting matching than that will take even more time for cutting, there is lot of manual rework due to improper shelling.

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*E. Bucket elevator*



Fig. 1 Inclined bucket elevator

A bucket elevator is a mechanism for carrying flow able bulk material along vertical or inclined path, and for transporting articles between various operations in production flow line. It also maintain the uniform flow rate of the product .They have wide applications in all branches of industry. Simple in design, easy maintenance and high reliability of operation.

*F. Specifications Of The Components In Bucket Elevator*

Table VI Cost Estimation Of Bucket Elevator

| Sr. No. | Name of component | Specifications | Quantity | Cost / Unit (Rs.) | Amount (Rs.) |
|---|---|---|---|---|---|
| 1. | Supports and Angles | Material: - M.S. | | | 1500 |
| 2. | Bearing | Type :- DGBB<br>Material: -<br>S.S. Diameter :- 40 mm | 2 | 400 | 800 |
| 3. | Shaft | Material :-<br>M.S. Diameter :- 40mm<br>Length :- 300 mm | 2 | 500 | 1000 |
| 4. | Washers | Material: -<br>M.S Diameter. :8 mm | 160 | 1 | 160 |
| 5. | Bucket rods | Material :-<br>Iron Diameter :- 8mm<br>Length :- 250 mm | 80 | 15 | 1200 |
| 6. | Lock nut | Material :-<br>S.S. Diameter: -8 mm | 160 | 1 | 160 |
| 7. | Rollers | Material :- Nylon, | 160 | 4 | 640 |
| | | Teflon Diameter :-8 mm | | | |
| 8. | Bucket | Material :- M.S., S.S.,<br>Nylon Size :- 210 mm × 550 mm | 80 | 50 | 4000 |
| 9. | Motor | Phase :- 3<br>Phase Power :- 1 HP Speed :-30 – 125 rpm<br>Voltage: - 220 | 1 | | 10000 |
| | | | | Total | 19,460 |

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*G. Calculation of OEE after improvement (Revised OEE)*

*1) OEE For Sorting Machine*

TABLE VII
WORKSHEET OF REVISED OEE FOR SORTING MACHINE

| **Overall Equipment Effectiveness Worksheet** | | | | | | |
|---|---|---|---|---|---|---|
| Machine:- RCN Sorting Machine | | | | | | OEE |
| OEE Data | | | | | | |
| No. of Shifts | 1 | | | | | |
| Shift duration | 8 hours shift (8 AM to 4 PM) | | | | | |
| Shift length | 480 | | Minute per shift | | | |
| Short breaks | 2 | Breaks@ | 115 | Min each | 30 | Minutes |
| Meal breaks | 1 | Break@ | 330 | Min each | 30 | Minutes |
| Machine ideal time | 120 | Minutes | | | | |
| Minor stoppage | 10 | Minutes | | | | |
| Planned maintenance | 20 | Minutes | | | | |
| Unplanned maintenance | 10 | Minutes | | | | |
| Planned production time | 280 | Minutes | | | | |
| Actual operating time | 260 | Minutes | | | | |

| **PERFORMANCE** | | | |
|---|---|---|---|
| Sample quantity | 50 kg | Sorting time | 7 minutes |
| Actual quantity made | 429 kg | Sorting time | 60 minutes |
| Theoretical quantity made | 600 kg | Sorting time | 60 minutes |

| **QUANTITY** | |
|---|---|
| For sample of 50 kg of 'C' grade | |
| Whole cashew | 14.00 kg |
| Pieces | 0.623 kg |
| Uncut | 1.309 kg |
| Manual rework | 0.496 kg |
| Shells | 33.58 kg |
| Total quantity made | 16.42 kg |
| Good quantity | 14.00 kg |

| **OEE calculations** | | | |
|---|---|---|---|
| **OEE factors** | **Calculations** | **OEE** | **OEE %** |
| Availability | Actual operating time/Planned operating time | 0.9285 | 92.85% |
| Performance | Quantity made/Theoretical quantity | 0.7865 | 78.65% |
| Quality | Quantity of good products/Total quantity made | 0.8526 | 85.26% |
| Overall OEE | Availability × Performance × Quality | 0.6099 | 60.99% |

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Table VIII Worksheet Of Revised Oee For Cutting Machine

| Overall Equipment Effectiveness Worksheet | | | | | | |
|---|---|---|---|---|---|---|
| Machine:- RCN Cutting Machine | | | | | | OEE |
| OEE Data | | | | | | |
| No. of Shifts | 1 | | | | | |
| Shift duration | 8 hours shift (8 AM to 4 PM) | | | | | |
| Shift length | 480 | | Minute per shift | | | |
| Short breaks | 2 | Breaks @ | 115 | Min each | 30 | Minutes |
| Meal breaks | 1 | Break@ | 330 | Min each | 30 | Minutes |
| Minor stoppage | 10 | Minutes | | | | |
| Set up and changeover time | 10 | Minutes | | | | |
| Planned maintenance | 20 | Minutes | | | | |
| Unplanned maintenance | 10 | Minutes | | | | |
| Planned production time | 360 | Minutes | | | | |
| Actual operating time | 320 | Minutes | | | | |
| PERFORMANCE | | | | | | |
| Sample quantity | 19 kg | Cutting time | 7 minutes | | | |
| Actual quantity made | 85.71 kg | Cutting time | 60 minutes | | | |
| Theoretical quantity made | 100 kg | Cutting time | 60 minutes | | | |
| QUANTITY | | | | | | |
| For sample of 50 kg of ‘C’ grade | | | | | | |
| Whole cashew | 14.00 kg | | | | | |
| Pieces | 0.623 kg | | | | | |
| Uncut | 1.309 kg | | | | | |
| Manual rework | 0.496 kg | | | | | |
| Shells | 33.58 kg | | | | | |
| Total quantity made | 16.42 kg | | | | | |
| Good quantity | 14.00 kg | | | | | |
| OEE calculations | | | | | | |
| OEE factors | Calculations | | | | OEE | OEE % |
| Availability | Actual operating time/Planned operating time | | | | 0.8971 | 89.71% |
| Performance | Quantity made/Theoretical quantity | | | | 0.8600 | 86.00% |
| Quality | Quantity of good products/Total quantity made | | | | 0.8526 | 85.26% |
| Overall OEE | Availability × Performance × Quality | | | | 0.6505 | 65.05% |

## IV. CONCLUSIONS

As per the conventional method of sorting of cashews used in Paranjape agro industry gives OEE for sorting machine is 52% and for cutting machine it is 42% which is comparatively less than world class OEE. In this project work this problem is solved using bucket type elevator for feeding the raw cashews in to RCN sorting machine. After implementing Bucket elevator for sorting machine improved OEE are mentioned in table below.

In Paranjape Agro industry after implementing the Bucket elevator the Availability, Performance & Quality of the RCN sorting & cutting machine is improved & hence leading to an increase in productivity

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Table IX Results

| OEE Factors | Revised OEE of sorting Machine | | Revised OEE of cutting Machine | | World Class OEE |
|---|---|---|---|---|---|
| | Conventional method | Using Bucket elevator | Conventional method | Using Bucket elevator | |
| Availability | 92.85% | 92.85% | 88.88% | 89.71% | 90% |
| Performance | 71.65% | 78.65% | 60% | 86.00% | 95% |
| Quality | 81.81% | 85.26% | 81.91% | 85.26% | 99.9% |
| OEE | 52.90% | 60.99% | 42.12% | 65.5% | 85% |

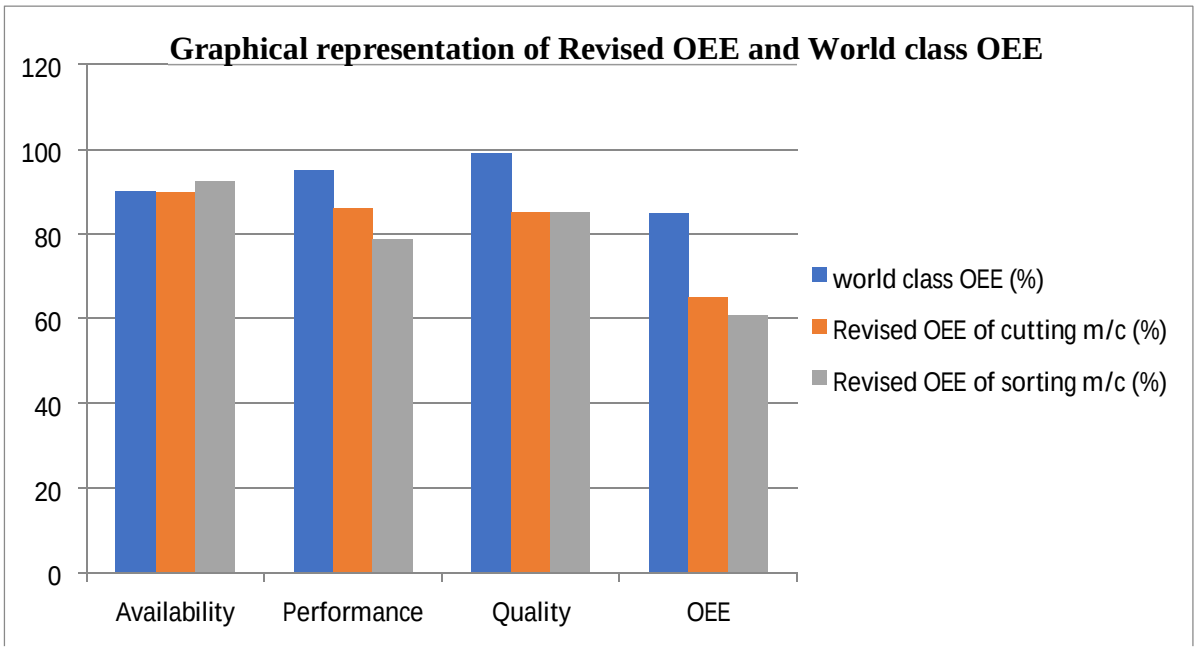



Fig. 2 Graphical representation of revised OEE and world class OEE

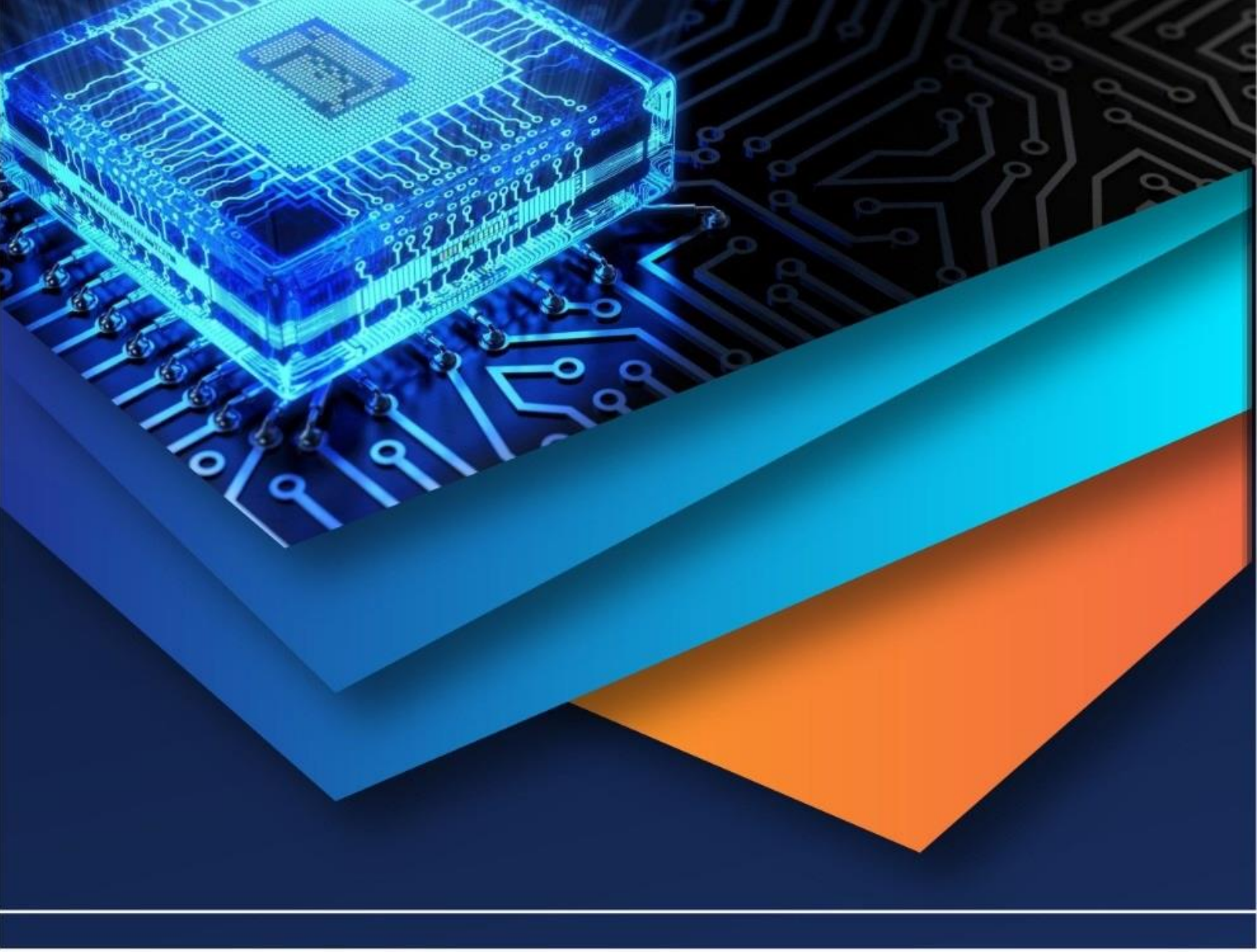
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