

Overall Equipment Efficiency

→ Guide

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A practical guide to **OEE**

In the fast-paced world of manufacturing, efficiency isn't just an advantage—it's a competitive necessity. Companies today face relentless pressure to boost production, cut costs, and uphold the highest quality standards.

Achieving this delicate balance hinges on a deep understanding of operational efficiency, and that's where Overall Equipment Effectiveness (OEE) comes into play. OEE is more than just a performance metric; it's a comprehensive measure of how effectively your manufacturing operations utilise resources.

By providing crucial insights into equipment availability, performance, and quality, OEE helps identify waste, optimise processes, and enhance productivity. With the advent of Industry 4.0, where smart manufacturing and digital transformation are reshaping industries, OEE has gained even more significance.

This eBook is written as a go-to guide for OEE, covering:

- The basics of OEE
- How to measure and enhance OEE
- Cutting edge strategies for improvement
- The pivotal role of TPD (Total Productive Maintenance)
- and how Industry 4.0 technologies are setting new benchmarks for operational excellence.

Whether you're new to OEE or looking to refine your approach, we hope this guide equips you with the insights and tools you need to elevate your operations and outpace the competition in the ever-evolving manufacturing landscape.

The smarter factory



Understanding the FMCG Packaging Industry

The FMCG packaging industry is characterised by high-speed production lines, frequent product changeovers and a constant need for innovation.

Packaging not only protects the product but also plays a significant role in marketing and brand identity. The industry's fast pace requires manufacturers to be agile and efficient, with minimal tolerance for downtime or defects.

The role of OEE in FMCG packaging

OEE is particularly important in the FMCG packaging industry because it directly impacts the bottom line.

High OEE means that equipment is running efficiently, producing high-quality products at the desired speed, and minimising waste.

Low OEE, on the other hand, can lead to higher costs, missed deadlines, and dissatisfied customers.

Key challenges in FMCG packaging

- **High-speed production:** The need to maintain high efficiency at high speeds.
- **Product diversity:** Managing frequent changeovers while maintaining high OEE.
- **Quality control:** Ensuring that every product meets quality standards without slowing down production.
- **Safety:** Avoidable accidents, damage to equipment, compliance and reporting and cyber security.
- **Cost of ownership:** Purchase price of equipment and expected working life, maintenance, repairs and staff training.

Improving OEE is crucial for manufacturers aiming to maximise productivity and maintain competitiveness in a dynamic market.

Understanding OEE



Overall Equipment Effectiveness (OEE) is the gold standard for measuring manufacturing productivity.

It's a key performance indicator (KPI) that has been used since the 1960s to simplify the performance of complex processes into a single metric.

OEE provides a clear, actionable snapshot of how well your equipment is performing, combining three critical factors

The simple formula is: $OEE = \text{Availability} \times \text{Performance} \times \text{Quality}$.

- 1. Availability:** The percentage of scheduled time that equipment is available to operate.
- 2. Performance:** The speed at which equipment runs as a percentage of its designed speed.
- 3. Quality:** The percentage of good units produced out of the total units started.

$$OEE = \text{Availability} \times \text{Performance} \times \text{Quality}$$

Why OEE matters:

OEE is more than a key performance metric—it's a strategic tool for driving operational efficiency. If you get it right, it's a metric that can yield huge gains—30-40% capacity improvement is not unheard of.

By analysing OEE, you can pinpoint losses, prioritise improvements, and benchmark your performance against industry leaders.

High OEE scores correlate with reduced downtime, optimised production speeds, and minimal defects, all leading to increased profitability and competitive advantage.

Industry 4.0 and OEE:

The fourth industrial revolution, known as Industry 4.0, is transforming the way manufacturers approach OEE.

By integrating cyber-physical systems, IoT, and smart manufacturing technologies, Industry 4.0 allows for real-time data collection, advanced analytics, and automated decision-making.

This revolution enables manufacturers to monitor, analyse, and enhance OEE with unprecedented accuracy and speed, setting new standards for operational excellence.

Let's be clear on what OEE is



You'll also hear terms such as Line Efficiency or Overall Line Efficiency (OLE). What's the difference?

In short, OEE measures how well individual machines perform, while line efficiency measures how well all machines work together.

OLE brings these together to assess how well the entire system functions.

OEE: Machine-focused

Overall Equipment Effectiveness focuses on the performance of individual machines within the production line.

"Effectiveness" refers to the degree to which the machine is successful in producing the desired result. Each machine's availability, performance and quality directly affect the overall output of the line.

For example: If one machine has a low OEE, it can cause disruptions, bottlenecks, or downtime for the entire line, reducing the overall line efficiency.

Line Efficiency: System-focused

Line efficiency measures the productivity of an entire production line, rather than a single machine.

"Efficiency" refers to the ability of the line to achieve the desired research with the least amount of wasted time, money, resources, and effort. It looks at how efficiently all machines and operations work together to produce output relative to its total capacity.

Line efficiency focuses on factors such as:

- **Throughput:** How much product the line produces over a period of time.
- **Downtime across the line:** The impact of stoppages or slowdowns that affect the entire production line.
- **Bottlenecks:** Any stage in the process that slows down the

overall flow of production, impacting the efficiency of other machines or operations on the line.

OLE: Combines both

Overall Line Efficiency (OLE) is a broader metric that incorporates both OEE (Overall Equipment Effectiveness) and Line Efficiency to provide a comprehensive evaluation of the entire production line's performance.

OLE reflects how efficiently all machines and operations in the line work together to achieve production goals, integrating the effectiveness of individual machines (OEE) with the coordination of the entire line (Line Efficiency). It also takes into consideration labour hours.

You can read a white paper on OLE (and how to achieve it) [here](#).



Measuring OEE



To optimise your equipment's effectiveness, you need to measure OEE accurately. This involves calculating three components—Availability, Performance, and Quality—each offering critical insights into different aspects of your production process.

1. Availability

- **Formula:** $(\text{Operating Time} / \text{Planned Production Time}) \times 100$
- **Explanation:** Availability considers all events that stop planned production for a significant duration. For example, if a machine is scheduled to run for 8 hours but operates for only 7 due to breakdowns or setup, its Availability would be 87.5%.

2. Performance

- **Formula:** $(\text{Ideal Cycle Time} \times \text{Total Count}) / \text{Operating Time} \times 100$
- **Explanation:** Performance measures whether equipment is running at maximum speed. If a machine designed to produce 1,000 units per hour produces only 800 due to inefficiencies, its Performance rate is 80%.

3. Quality

- **Formula:** $(\text{Good Count} / \text{Total Count}) \times 100$
- **Explanation:** Quality reflects the percentage of defect-free units produced. If 950 out of 1,000 units are defect-free, the Quality rate is 95%.

Overall OEE

- **Formula:** $\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$
- **Explanation:** If a machine has an Availability of 87.5%, Performance of 80%, and Quality of 95%, the overall OEE would be:

$$\text{OEE} = 0.875 \times 0.8 \times 0.95 = 0.665 \text{ or } 66.5\% \text{ OEE}$$

Key metrics and benchmarks

A high OEE score is a hallmark of an efficient production process. Industry benchmarks provide a context for what constitutes a “high” score:

- **85% and above:** World-class OEE, indicating a highly efficient operation.
- **60% to 85%:** Typical for discrete manufacturers, with room for improvement.
- **Below 60%:** Indicates significant inefficiencies, presenting ample opportunities for improvement.

Note that for some industries, lower OEE score are the standard. Regularly benchmarking your OEE against industry standards helps set realistic goals and measure progress over time.

Challenges in measuring OEE

Despite its straightforward calculations, accurately measuring OEE can be challenging due to factors such as:

- **Data collection:** Manual data collection can lead to inaccuracies and delays. Automated systems offer more precise, real-time data.
- **Complex production lines:** In operations with multiple machines or complex processes, calculating OEE for the entire line can be complex. Breaking it down into segments can simplify this.
- **Human error:** Errors in data entry or downtime categorisation can skew OEE results.

Enhancing OEE measurement with Industry 4.0:

Industry 4.0 technologies provide solutions to these challenges by enabling real-time monitoring, automated data collection, and advanced analytics.

Smart sensors and IoT devices continuously feed data into centralised systems, ensuring accurate and consistent OEE tracking. Predictive analytics can forecast potential downtimes or inefficiencies, allowing for proactive maintenance and adjustments.



Strategies for improving OEE



Improving Overall Equipment Effectiveness (OEE) is not just about monitoring metrics—it's about taking decisive actions to enhance every aspect of your operations.

Let's look at practical strategies for boosting OEE, focusing on actionable approaches to improving Availability, Performance, and Quality.

Identifying bottlenecks and inefficiencies:

The first step in improving OEE is identifying inefficiencies within your production process.

Common sources include:

- **Unplanned downtime:** Equipment breakdowns, unscheduled maintenance, or material shortages that impact Availability.
- **Slow cycle times:** Machines running below optimal speed due to operator errors, wear, or improper settings, affecting Performance.
- **Quality defects:** Defects lead to rework, scrap, and wasted materials, reducing your Quality score.

Tools like root cause analysis (RCA) and Pareto charts can help systematically identify and address these inefficiencies.

Practical tips for improving each component of OEE:

1. Improving Availability

- **Scheduled maintenance:** Implement preventive maintenance schedules to minimise unexpected breakdowns. Predictive maintenance, enhanced by Industry 4.0, can further reduce downtime.
- **Quick changeovers:** Streamline changeover processes using SMED (Single-Minute Exchange of Die) techniques to reduce time between production runs.
- **Training operators:** Well-trained operators can efficiently handle equipment and troubleshoot issues, reducing downtime.

2. Enhancing performance

- **Optimise machine settings:** Regularly review and adjust machine settings to ensure optimal operation speeds. This may involve equipment or software updates.
- **Monitor production rates:** Real-time monitoring tools can help track production rates and identify slowdowns.
- **Continuous improvement programs:** Implement methodologies like Kaizen to encourage ongoing, incremental improvements in machine performance.

3. Boosting Quality

- **Automated quality control:** Utilise automated inspection systems to detect defects early, reducing the number of defective parts produced.
- **Employee engagement:** Foster a culture where operators take pride in producing high-quality, defect-free parts and are encouraged to report issues.

- **Process standardisation:**

Standardise procedures to ensure consistency and reduce the likelihood of defects.

The role of data-driven decision-making:

Data is crucial in improving OEE. By leveraging production data, companies can make informed decisions that lead to significant improvements.

Key data strategies include:

- **Real-time monitoring:**

Use real-time data to identify issues as they arise, allowing for immediate corrective actions.

- **Historical data analysis:**

Analyse historical data to spot trends and recurring issues, aiding in maintenance planning and predicting potential breakdowns.

- **Performance dashboards:**

Implement dashboards that visually represent OEE metrics, making it easier for management and operators to act on data.

improvement to the next level. Predictive maintenance uses data from IoT sensors and machine learning algorithms to forecast equipment failures, allowing for scheduled maintenance before breakdowns occur. Real-time optimisation tools adjust machine settings and production schedules based on current conditions, maximising Performance and Quality.

Leveraging Industry 4.0 for predictive maintenance and real-time optimisation:

Industry 4.0 technologies enable predictive maintenance and real-time optimisation, taking OEE



DATA STRATEGIES



Total Productive Maintenance (TPM) and OEE



Total Productive Maintenance (TPM) is a holistic approach to equipment maintenance that aims for perfect production with zero breakdowns, zero defects, and zero accidents. TPM's proactive and preventive strategies directly contribute to improving OEE.

TPM is built on eight foundational pillars, each designed to improve efficiency and productivity across various aspects of manufacturing:

1. Autonomous maintenance:

Operators are empowered to handle routine maintenance tasks, such as cleaning, lubrication, and inspection. This reduces the burden on specialised maintenance teams and helps prevent breakdowns by addressing issues before they escalate.

2. Planned maintenance:

Maintenance activities are scheduled based on historical data and the actual condition of the equipment, minimising unexpected breakdowns and extending equipment life.

3. Quality maintenance:

The focus here is on eliminating defects and ensuring that processes consistently

produce high-quality products. This involves identifying and addressing root causes of defects.

4. Focused improvement:

Teams are engaged in continuous improvement activities aimed at solving chronic problems and enhancing equipment performance. This pillar drives the relentless pursuit of incremental gains.

5. Early equipment management:

This involves integrating maintenance considerations into the design and installation of new equipment to ensure long-term reliability and ease of maintenance.

6. Training and education:

Comprehensive training is provided to operators and maintenance personnel, building a skilled workforce capable of maintaining and improving equipment effectively.

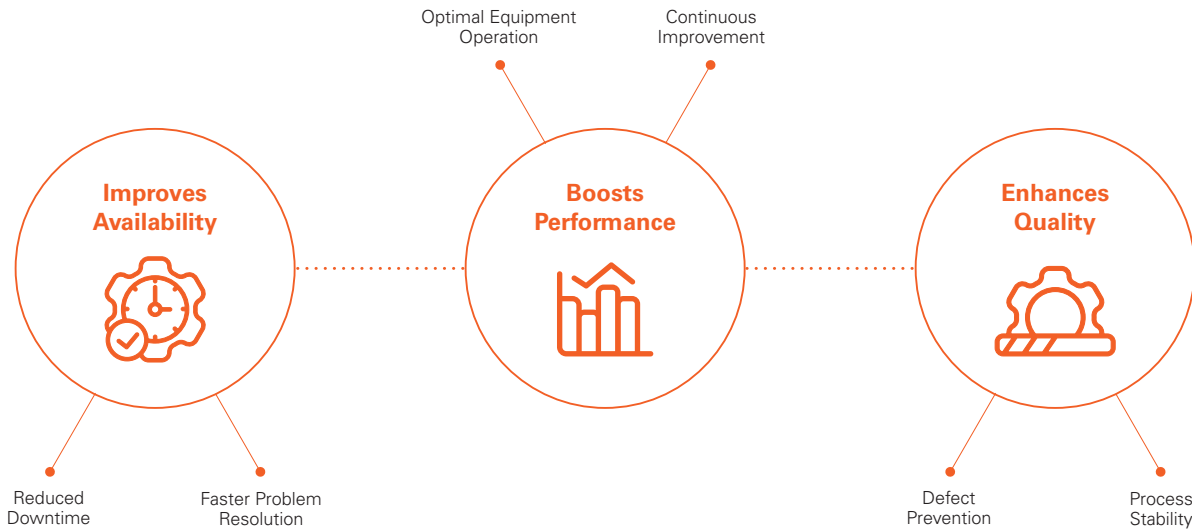
7. OH&S:

Ensuring that all maintenance activities are conducted safely and that equipment poses no risks to workers or the environment. This pillar reinforces the importance of a safe and sustainable work environment.

8. Office TPM:

Extending TPM principles to administrative functions to improve efficiency and support manufacturing operations. This holistic approach ensures that every part of the organisation contributes to overall efficiency.

HOW TPM ENHANCES OEE



TPM directly impacts the three components of OEE—Availability, Performance, and Quality—by systematically improving equipment maintenance and operations.

1. Improves Availability

- Reduced downtime:** Autonomous and planned maintenance activities reduce unplanned downtime, ensuring that equipment is available when needed. By involving operators in maintenance, potential issues are identified and resolved before they lead to significant breakdowns.
- Faster problem resolution:** TPM emphasises the quick identification and resolution of issues, reducing the time equipment is out of operation.

2. Boosts Performance

- Optimal equipment operation:** Regular maintenance ensures that equipment operates at its designed speed, reducing performance losses. TPM also encourages operators to better understand their equipment, leading to more efficient operation.
- Continuous improvement:** Focused improvement drives ongoing efforts to enhance equipment performance by eliminating inefficiencies and optimising processes.

3. Enhances Quality

- Defect prevention:** Quality Maintenance activities focus on identifying and eliminating the root causes of defects, leading to a higher percentage of good parts and a better Quality score.
- Process stability:** By maintaining equipment in optimal condition, TPM helps ensure that production processes are stable and capable of consistently producing high-quality products.

Case Studies: Real-World Examples of TPM Improving OEE



Case Study 1:

High-speed beverage manufacturing plant

- **Challenge:** A beverage manufacturer faced frequent equipment breakdowns, leading to production delays and inconsistent quality, which resulted in low OEE scores.
- **Solution:** The company implemented TPM with a focus on Autonomous Maintenance and Quality Maintenance. Operators were trained to perform routine checks and basic maintenance, while a specialised team addressed the root causes of defects affecting product consistency.
- **Result:** The plant saw a 25% reduction in unplanned downtime and a 20% improvement in product quality within six months, significantly enhancing their OEE.



Case Study 2:

FMCG personal care products manufacturer

- **Challenge:** A manufacturer of personal care products struggled with high levels of waste due to frequent equipment stoppages and product defects during the packaging process.
- **Solution:** The company introduced TPM, focusing on Planned Maintenance and Focused Improvement. Maintenance schedules were optimised using historical data, and cross-functional teams were established to reduce waste and improve packaging line efficiency.
- **Result:** The manufacturer achieved a 15% increase in line efficiency and a 30% reduction in waste, leading to a notable improvement in their OEE.



Case Study 3:

Industrial batch production facility

- **Challenge:** An industrial batch production facility was experiencing inconsistent production speeds and frequent equipment malfunctions, negatively impacting their OEE.
- **Solution:** The facility adopted TPM, focusing on Early Equipment Management and Autonomous Maintenance. New equipment installations were designed with ease of maintenance in mind, and operators were trained to handle routine maintenance tasks.
- **Result:** The facility reported a 20% improvement in equipment performance and a 25% reduction in downtime, resulting in a significant boost in their OEE.

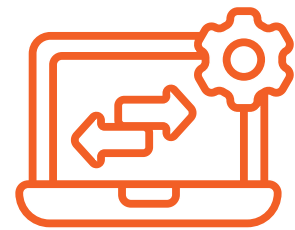
Integrating TPM with Industry 4.0 technologies:

Industry 4.0 technologies further enhance TPM by providing real-time data and predictive insights, enabling even more proactive maintenance strategies.

Examples include:

- **IoT sensors:** Connected sensors continuously monitor equipment health and provide early warnings of potential issues, allowing maintenance to be scheduled before failures occur.
- **Predictive analytics:** Machine learning algorithms analyse historical and real-time data to predict when and where maintenance is needed, optimising Planned Maintenance schedules.

- **Digital twins:** Virtual replicas of physical equipment can be used to simulate maintenance activities and predict the impact of changes, ensuring that TPM strategies are as effective as possible.



By combining TPM with Industry 4.0 technologies, companies can achieve unprecedented levels of OEE, ensuring that their equipment is always available, operating at peak performance and producing high-quality products.

