Persistent

Key Tactics to Increase Overall Equipment Effectiveness:

Practical Challenges and Recommendations

Why does industry care about OEE

In today's competitive world, manufacturers face several difficult challenges in the production environment. It is becoming crucial for the manufacturers to drive down the cost per unit of the manufactured product, without compromising the flexibility and agility to customize the products to provide personalized experiences to consumers. An engineering team's ability to manufacture a product concept devised by the marketing and design team and implement it quickly (using existing machinery without sacrificing product run rate) can mean the difference between success and failure of a product.

To handle the above challenge and ensure they are up to the mark with continuous improvement, the manufacturing industry has long back devised frameworks and mechanisms such as Overall Equipment Efficiency (OEE). OEE was first described as a central component of the Total Production Management (TPM) methodology by Seiichi Nakajima from Japan. OEE has proven to be useful in the following ways -

- The best way to use OEE in production is as a yardstick for measuring improvement against a defined baseline.
- Further, it can be used as a benchmark to compare the performance of a given production asset to industry standards, to similar in-house assets, or results from different shifts working on the same asset.

Getting an OEE score of 80 - 85% is considered best in class for manufacturers[1]. However, based on various market reports, many manufacturing lines are only 60 to 70% productive, indicating there are tremendous opportunities for improvement.

Given the importance of OEE in a manufacturing organization, still ensuring the right implementation and its effectiveness has been a key challenge to solve. Towards this, we share here the current state of how typically OEE is implemented in the industry based on our findings and experience of working with various customers. Further, we discuss how the latest technologies can be employed to make OEE a very effective tool in ensuring continuous improvement. Market survey and research has shown that deploying IoT based mechanisms for tracking OEE metrics helps improve production effectiveness by 20 to 25%.

Key requirements to compute OEE

For any entity, e.g., a machine, OEE is computed based on following three parameters —

- **Availability** of the machine,
- **Quality** of the product manufactured by the machine and
- Production **performance** of the machine

In simple terms, OEE measures the percentage of planned production time that is truly productive. Availability gives insight into overall unplanned downtime of the equipment. Quality provides an insight into the rejection of the produced products for lack of good quality. Performance indicates how much the production has met its target of producing the products. There are many blogs/references which give details and recommendations about the formulae that are used to compute these metrics.

The Current state of OEE implementation in industry

Based on the experience of working with many manufacturing enterprises, we see that though OEE is an accepted concept to ensure continuous improvement, the way it is implemented generally makes it less effective. The common trends we saw in its implementation are —

- Downtime, Rejections, and Production data are manually recorded by workers on paper and submitted in batches to the supervisor for calculations.
- OEE is computed manually in tools such as spreadsheets or by feeding data to ERP systems.

This approach results in the following challenges —

1. **Inaccuracies in data:** It introduces inaccuracies in the data capture due to the manual way of capturing the data. Workers may make mistakes while capturing the data. It makes it difficult to capture minor stops, which are of only a few minutes, such as the ones less than 5 to 10 minutes. Further, reasons for the small downtimes may not be captured correctly.
2. **Not real-time:** No real-time indication/alerts on significant deviations in OEE are available. Since it is a manual activity, OEE is computed once in a day/week/month. OEE is later displayed on a plant floor notice board on a paper printout. This makes it difficult to get due importance and priority from different members of the team and to act on it in real-time.
3. **Limited analysis:** Data analysis is limited as it is done manually using certain tools such as Excel. This can result in missing some important trends in the behavior of the machines/lines/plant.

What approach should industries adopt in OEE implementation

The above challenges faced in computing and monitoring the OEE can be overcome by incorporating the latest developments in the IoT and data technologies. As per Gartner[2], OEE computation is becoming mainstream, as the Organizations are adopting a more extensive set of metrics for monitoring and analyze their interdependence on manufacturing performance. Further, these technologies improve the accuracy of computation and add truth to the measure. It is expected to mature and become mainstream in 2020. Based on the industry trends, it is recommended for an organization to adopt the following approach for OEE computation —

1. Collect data in an automated way from PLCs, data historians, and/or SCADA systems.
2. Deploy IIoT systems with edge IoT gateways. These gateways usually support connectivity to all major brands/types of PLCs and can collect required data for computations.
3. Consider cloud-based deployment for the backend system and dashboards. These help to reduce CAPEX and various other on-premise maintenance expenses.
4. Employ a data-centric approach and analyze trends in the machine/line/plant effectiveness.
5. Enable real-time alerts over deviations in OEE from trends to take timely corrective action.

How the industry should navigate the challenges faced during IIoT based OEE implementation

After an organization has agreed to go ahead with an IIoT based OEE system, there are certain challenges they may encounter. Based on our experience of working with different customers for their IIoT based OEE implementation, below are our suggestions on how organizations can navigate these challenges.

To implement an OEE system, an organization need to address the following challenges —

- **Ensuring data capture:** It is important to capture machine events which are related to its downtime, production throughput, and quality of the product produced. Identifying the right mechanism to capture required data in an automated way and implementing these is a challenge that IT and operations stakeholders need to address jointly.
- **Ensuring data accuracy:** As with any other data-driven system, just capturing data is not enough, but the correctness and accuracy of the data play an important role. The system needs to ensure these parameters for the captured data.

We recommend following ways to address above challenges —

Ensuring data capture: Following are the suggested ways to ensure data capture –

- **Automated data capture:** The ideal way to ensure data capture is through an automated mechanism via PLC interfaces, which could include the performance data about the units manufactured, quality data through visual inspection, or machine downtime data.
- **Manual data capture:** In addition to the above, whenever automated data capture is difficult or needs to be supplemented with additional data, the system can provide an HMI interface for workers to key-in the required data.

  Interlocking: While the HMI interface is provided to key in the required data, this may not be sufficient as we know the adoption of any new technology or a new process takes time with the workers. This has direct impact on the required data collection. To handle this, wherever possible, it is necessary to interlock the machine to capture the data. One such example is while capturing machine downtime reasons. In this case, the workers will be required to key-in the reasons before they can re-start the machine.

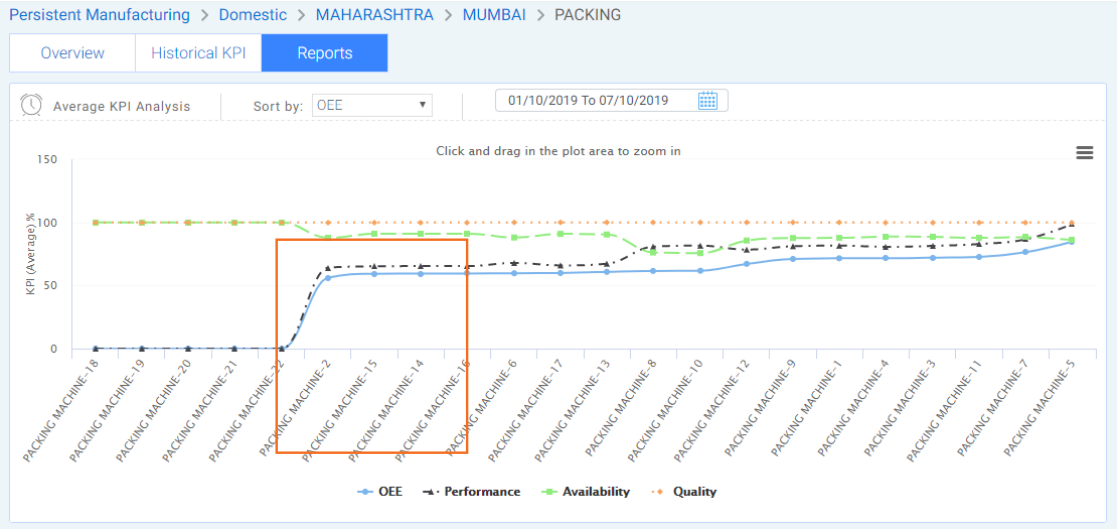
Ensuring data accuracy through historical data analysis: To ensure accuracy of the collected data, the system verifies it with historical data analysis and related techniques. In case there is any deviation or anomaly detected, the same is presented for further verification or review from the supervisors. Comparative analysis can also be done across machines/lines of the similar or same type to identify any deviations for further investigation.

Best practices around the OEE implementation

Following are certain suggested best practices that an organization should follow while implementing the OEE system. These are based on our experience of working with different customers and have proven to make the OEE system more effective.

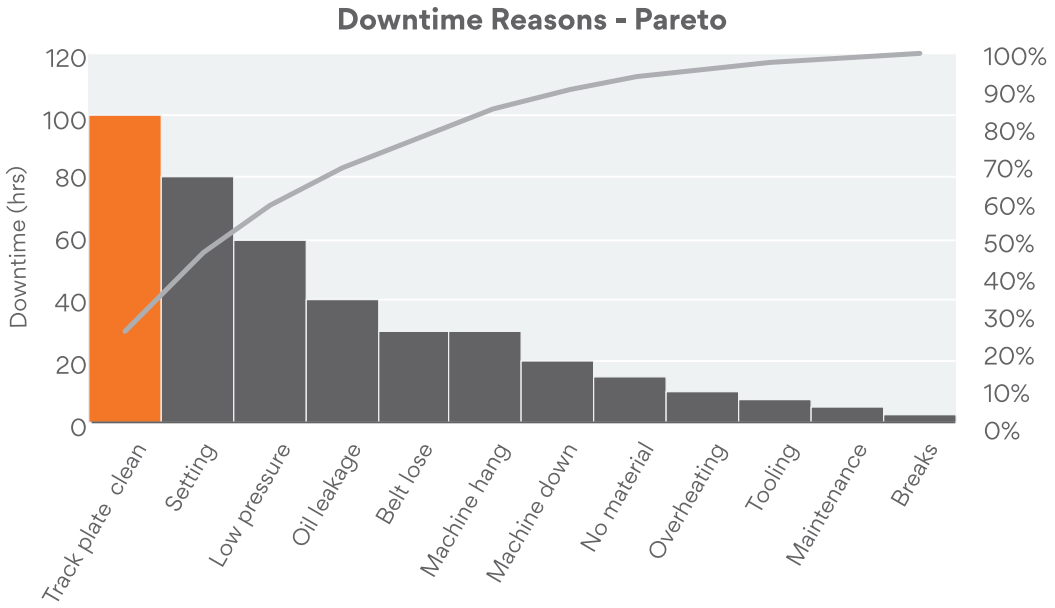
Know your bottom performers: Improving bottom performers involves a two-step process as below —

1. **Identify:** Based on the historical OEE performance of all the machines, the system recommends a set of bottom-most performing machines. These are the candidates who call for immediate attention to bring up the overall effectiveness of the line/plant.
2. **Recommended action:** Apart from highlighting the bottom performers, the system also recommends actions to be taken to improve their performance. The recommendations are based on various aspects such as historical data analysis and anomalies detected in the past.



Typical chart indicating bottom most performing machines

Identify major reasons for the downtimes: Identify the major reasons of the downtimes as recorded by the system. The system provides Pareto chart which indicates the reasons covering 80% of the downtime duration. Improving these will improve the overall effectiveness of the machine.



Typical Pareto chart indicating downtime reasons distribution

Follow recommended templates to include different operational areas in OEE calculations: OEE computation is usually based on many operational areas of production. This complexity is addressed as follows —

1. **Challenge:** There are many factors that can influence the OEE value. This makes it difficult to decide which areas should one include in the calculations. As an example, consider we want to monitor change-over time and its impact on production efficiency. In this case, change-over time should be considered as an unplanned downtime in the Availability calculation. If it is considered as a planned downtime then it will get excluded from the calculation and any increase in it will not get noticed which otherwise will reduce the production efficiency.
2. **Templatized data model:** To address the above challenge, the system provides a templatized data model and mechanism which can be quickly put in practice. It is based on the experience of working with different customers in discrete manufacturing. This helps to quickly setup the OEE system and get started covering all the important operational areas.

Key takeaways

1. We have discussed how IoT based OEE can improve the current state of its implementation. Various market case studies and research have shown an improvement in the range of 20 to 25% that amply justifies the RoI for its acceptance.

2. A data-driven approach to define, monitor and improve on the OEE has potential to address various challenges in the OEE implementation. This takes advantage of historical data analysis and latest advancements in machine learning technology to identify problem areas and provide diagnostic recommendations to improve on them.

3. The OEE system provides various capabilities based on the latest trends in the technologies which should be leveraged by an organization to put its production system on continuous growth trajectory.

Incorporate hierarchical factory model for OEE representation: The OEE system models complete organization and supports hierarchical representation as below—

1. **Top-down hierarchy:** A typical hierarchy is starting from Organization, going through all the divisions, plants under each division, lines under each plant, and finally machines on each line. This provides different perspectives to different stakeholders in the organization.
2. **Bottom-up calculations:** OEE calculations are done in an aggregated way starting from the bottom (machine level) and going up to the top level of the Organization. Such structure provides comparative effectiveness at each level – machines, lines, plants, divisions.
3. **Templatized data model:** The OEE system provides a templatized data model that can help to quickly model any complex hierarchy of an organization. This helps to quickly setup the OEE system and get started.

Compare OEE between similar type of machine/ line/plant: It makes sense to compare OEE only with machines/lines/plants which are of similar type. E.g., if two machines have different changeover time then it doesn't make sense to compare their OEE. The system's user interface provides comparison with the right set of machines/lines/plants.

Configure the right ideal cycle time and polling interval: It is observed that many times the performance of the machines could get calculated as above 100%. Following are the frequently observed causes for the same which results in this behavior and the recommended approach to address them.

- **Incorrect Ideal Cycle Time:** One key data point for correct performance calculation is getting the right Ideal Cycle time of the machine. Usually, this is specified as part of the machine specifications by the OEM. However, there could be variation in the actual ideal cycle time as compared to the rated one. The system addresses this by fine-tuning the Ideal cycle time based on the historical data captured by it.
- **High polling interval:** At times, the configured polling interval to fetch data from the PLC is set higher than the actual duration of the frequent downtimes observed. The downtime duration is primarily determined by the nature of the work or the machine. Such a situation results in inflated downtime intervals, which in turn reflects into showing higher throughput of the machine. It is recommended to determine the polling interval required based on the nature of machine/work. It should be kept sufficiently low as compared to the actual duration of the frequent downtimes. E.g., if average downtime interval of a machine is 10 minutes then polling interval should be kept around 5 minutes.

Focus on industry accepted "Six Major Losses" to improve OEE: While a lot can be done by putting IoT based OEE system in the production, one may want to start with a focus on important areas that are proven to improve the production efficiency.

These are described as “Six Major Losses” in production as listed below—

1. **Availability:** breakdowns and failures
2. **Availability:** setup and adjustments
3. **Performance:** small stops
4. **Performance:** reduced speed
5. **Quality:** start-up rejects
6. **Quality:** production rejects

The OEE system considers the above areas on priority to monitor and track them for improvement. It records various data points for these and presents them in different forms such as dashboard graphs, KPI, notifications and alerts, historical trends and diagnostic recommendations to improve on them.

Why Persistent

Persistent Systems has been running successful OEE production deployments for industrial customers. As highlighted above based on our experience of working with customers, we understand what it takes to make an OEE solution successful and help our customer get ROI from the same. Further we highlight below our key strengths in this area which in turn help our customer achieve the required success.

Predictive Analytics

While OEE enables you look to into past metrics to conduct trend and root cause analysis and get a sense of what might lie ahead, Persistent Systems can help you take the next step into true predictive analytics.

Our engineers and data scientists can properly model the data streams that OEE collects, then apply AI to the structured (and unstructured) data sets to predict the likelihood of when and how your assets might breakdown based on each asset’s anomaly thresholds and historical performance data.

This way, you’ll be able to identify, mitigate and potentially even prevent the expected downtime event from happening, keeping your assets fully operational and allowing you to pro-actively address potential situations before they can impact your business.

A smooth migration that pays for itself

While every manufacturing organization seeks the benefits that an OEE solution can provide, a smooth path to migration isn’t always clear, especially in a mission-critical area of the business like the production floor.

With more than 9,000 engineers and technical experts worldwide and more than 29 years of software and migration experience, Persistent Systems is used to developing and successfully executing platform migrations like this. OEE’s IoT Gateway can also be programmed to write to the AWS cloud and the legacy Data Historian for as long as needed until you’re comfortable shutting down the legacy on-premise solution.

Our engineers can get each asset on your factory floor set up quickly, including communication to the IoT Gateway, establishing performance parameters, and the like. At the same time, Persistent’s UI/UX team will fine tune the dashboards to your exact specifications and business rules to maximize your ROI and set up any alert notifications to contact specific users through a number of available channels.

Once your seamless migration is complete and your factory floor is being constantly monitored by the OEE in real-time, the benefits will be both concrete and immediate. The increase in uptime and productivity alone typically pays for the entire OEE investment within 4 – 6 months.

The vision of Industry 4.0 and the lasting competitive advantage it can deliver is a compelling one for manufacturing organizations. But for many companies encumbered with aging equipment and costly, on-premise data capture and reporting solutions, the vision can remain frustratingly out of reach.

Solutions like Overall Equipment Effectiveness from Persistent Systems blend the latest technologies into a single solution designed to help legacy manufacturers receive the full benefits of the digital transformation on their factory floor, allowing managers and other stakeholders to unlock and extract the maximum performance from the assets and processes in their control.

Let Persistent challenge your preconceptions of what’s possible.
www.persistent.com/industries/industrial/
to find out more and schedule a demonstration.

References:

[1] Overall Equipment Effectiveness: Benchmark Data by Industry [Sep 05, 2012]
LNS Research: Overall Equipment Effectiveness: Benchmark Data by Industry

[2] Hype Cycle for Manufacturing Operations Strategy, 2019 [Aug 02, 2019]
Hype Cycle for Manufacturing Operations Strategy, 2019

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Persistent Systems (BSE & NSE: PERSISTENT) builds software that drives our customers' business; enterprises and software product companies with software at the core of their digital transformation.
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