

IMPROVING MANUFACTURING PERFORMANCE WITH IOT ANALYTICS

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Tech-Clarity

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Improving Productivity Through Digitalization

The Strategic Importance of Digitalization

Digitalization is changing the landscape in manufacturing as companies adopt Industry 4.0, Smart Manufacturing, and Digital Transformation initiatives. In fact, a recent Tech-Clarity survey¹ shows that over one-half of manufacturers believe that digitalization / digital transformation initiatives are “important” if not “critical” to achieving their business strategy.

The Internet of Things (IoT) is a critical component of digitalization in the plant, helping companies connect with production assets to better monitor how they perform. Beyond gathering data, manufacturers can leverage advanced analytics to gain real intelligence about plants and production to improve operations, driver higher performance, and guide continuous improvement.



“Based on our research, the greatest potential for creating value will be in operations optimization—making the various processes within the factory more efficient.

Overall, IoT applications in operations optimization have the potential to create value of \$633 billion to \$1.8 trillion per year in the factory setting in 2025.”

The Internet of Things: Mapping the Value Beyond the Hype - McKinsey & Company

Justifying IoT Analytics Investments

For some companies, leveraging the Industrial IoT (IIoT) is simply a strategic “must do.” For others, they have to cost justify it. This eBook offers a framework to develop an ROI for IoT investments using a common manufacturing metric, Overall Equipment Effectiveness (OEE).

Analyzing improvement potential by OEE allows companies to determine potential savings in the context of the plant. The framework shows how companies can use the IoT and analytics to reduce the “Six Big Losses of OEE” and tangibly improve the three components of OEE – Availability, Performance, and Quality. Manufacturers can compare these improvement opportunities to the investment required to achieve them in order to calculate an ROI.

IoT, Analytics, and Overall Equipment Effectiveness

Quantifying Value to the Plant: OEE

Many manufacturers have reduced cost and improved quality by using Lean, Six Sigma processes to eliminate waste. Digitalization using the IIoT extends these improvements, helping manufacturers achieve even higher productivity.

We'll use OEE as a way to quantify the potential value by evaluating how IIoT analytics can improve each of the three OEE elements and related "Six Losses of OEE" that undermine productivity. OEE is a proven metric to benchmark performance and track progress for a workcell or a plant. While not all companies look at OEE the same way, it offers a valuable framework to identify and evaluate productivity improvements.

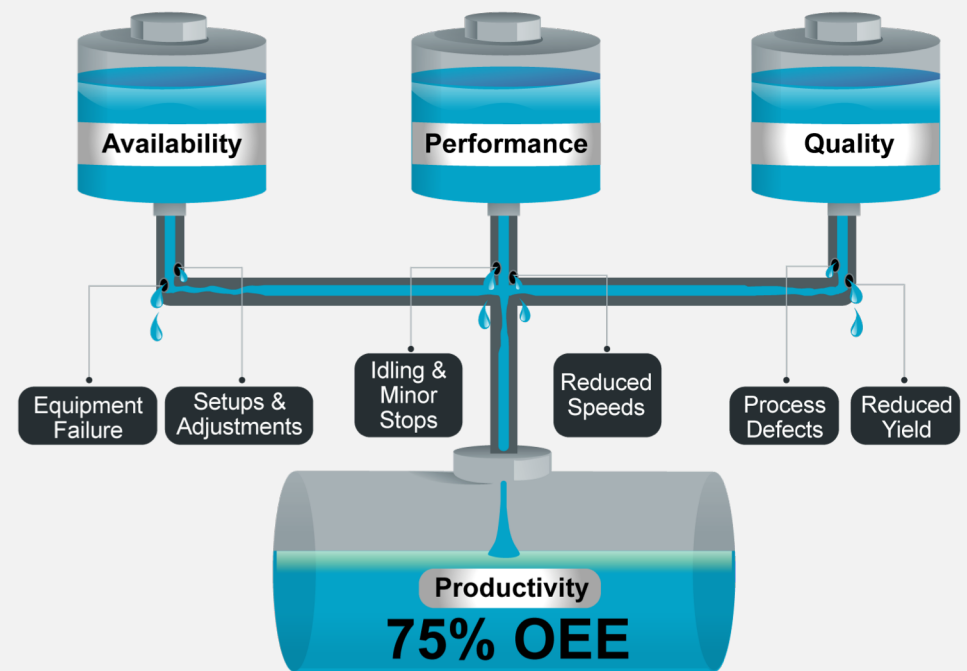
Improve IIoT Productivity

IIoT provides timely, detailed data to create knowledge about production performance. An effective IIoT platform can connect a variety of equipment and pull disparate information together in real-time to create dashboards, alerts, and triggers to create insights to drive corrective action.

Extends IIoT Value with Analytics

Analytics amplifies IIoT value by pulling together disparate information such as sensor data streams, environmental data, and information from enterprise systems like ERP,

The Six Losses of OEE



MES, EAM, or HRMS. Then, algorithms can uncover new and deeper insights by finding hidden trends and data relationships that produce manufacturing operational intelligence. For example analytics may use artificial intelligence (AI) to find correlations between quality defects and factors that might not be obvious, like a specific supplier or adherence to a setup procedure. Together with IIoT, analytics uncovers new opportunities to help extend productivity improvements.

Improve Equipment Availability

OEE Component 1: Availability

The first metric we'll discuss is Availability, which is measured as the percent of available runtime compared to the time production equipment is scheduled to operate. This metric is important because increasing equipment uptime drives higher throughput and delivers greater production value. The first two of the 6 losses we'll discuss, "Equipment Failure" and "Setups and Adjustments," directly impact Equipment Availability.

Reduce Equipment Failure

Downtime from broken equipment is a major source of lost productivity. IoT analytics reduce unplanned stoppage by helping manufacturers monitor equipment to keep it running. The primary source of value comes from identifying issues before they happen so equipment can be serviced off schedule.

Using algorithms to identify scenarios that commonly precede a failure helps manufacturers transform to predictive service. Servicing equipment before it breaks down improves Mean Time Between Failures, minimizing the disruption of breakdowns that cause cascading effects and escalate into bigger productivity losses.

Not all problems can be predicted, but faster identification and better knowledge of the situation helps minimize the

disruption by aiding with a rapid repair. Having the right information helps service personnel prepare the right parts, skills, tools, and knowledge, improving first time fix rates and Mean Time to Repair (MTTR).

Minimize Setups and Adjustments

The second of the OEE losses impacting availability are planned equipment pauses for setups, changeovers, and adjustments. While these may be necessary, they take away from productive time. IoT analytics help companies track actual frequency and duration of these events and identify anomalies or trends that could indicate issues or opportunities for improvement. Better insights may help uncover ways to make them more efficient, or associate pauses with factors that can be adjusted.

40%

Leica Microsystems reduced unscheduled downtime by 40%²

15%

Diebold reduced overall production line downtime by 15%²

\$1.2MM

GE Power increased uptime for their customers to save them \$1.2 million²

20%

Conservative estimate for improving Availability with IIoT & analytics is 20%

Improve Equipment Performance

OEE Component 2: Performance

The next area of focus is improving the Performance metric, also known as the process rate for a piece of equipment. Performance is measured as the speed at which production runs as a percentage of its ideal cycle time. This measure is important because it encourages maximum output from the time equipment is operating. The next two losses we'll analyze, "Idling and Minor Stops" and "Reduced Speeds," impact the OEE Performance measure.

Minimize Idling and Minor Stops

IoT analytics can help reduce idling and minor stops in a number of ways. First, it can help by reducing the need for in-process adjustments by dialing in specs more precisely based on analysis of past performance. It can also provide insights into which products require more stops and use machine learning to identify root causes that can be corrected. In addition, analytics can preemptively identify situations like material issues that could cause minor delays so they can be addressed before they impact productivity.

Prevent Reduced Speeds

The next loss measures slowed cycle times that reduce production volume. IoT analytics can help identify ways to run at full capacity without causing disruptions. It allows faster identification of issues because there is no latency

10-25%

We estimate the Internet of Things can increase productivity by 10 to 25 percent by improving production efficiency.³

50%

One manufacturer recently reduced downtime on a robotic manufacturing line by 50 percent and increased performance by 25 percent by leveraging a machine learning platform for its predictive algorithms.⁴

25%

Our conservative estimate for improving Performance with IIoT & analytics is 15%

20%

in metrics. IoT monitoring can quickly identify when equipment isn't running at intended speeds to provide greater visibility to the issue, while analytics can help companies monitor and find root causes.

Slow cycle times are often due to equipment failures. These failures can be identified proactively and prevented so equipment remains in top operating condition. Slow speeds may also be due to a suboptimal production process that could be identified by analytics. In addition, companies with robust IoT capabilities may be able to correct issues with a remote upgrade of the equipment configuration or controls to improve performance.

Improve Production Quality

OEE Component 3: Quality

The final OEE metric we'll discuss is Quality. IoT analytics can help ensure that produced units are acceptable, improve first pass yield / process yield, and limit scrap and rework. The last two OEE Losses we'll discuss directly impact the Quality aspect of OEE, and include "Process Defects" and "Reduced Yield."

Reduce Process Defects

Process defects, also thought of as production rejects, take away from profitable production yield. They also waste time and materials. IoT analytics can play a significant role in improving yield and minimizing waste. Monitoring production in real-time via the IoT helps quickly identify issues. For example, IoT can monitor automated measurement devices to quickly detect out of spec production. It can also ensure that equipment settings are correct via monitoring and adjusting with bidirectional communications and remote control.

Analytics extends this by identifying trends or spec slippage while production is still conforming so it can be adjusted to stay within tolerances. It can also help provide valuable insight into conditions leading to quality leaks so they can be identified and mitigated. Finally, IoT analytics "closes the loop" by feeding actual production information

back to process engineers to correct manufacturing design errors and optimize production processes.

Minimize Reduced Yield

The last OEE Loss, Reduced Yield, is closely related to Process Defects. It's typically considered losses that aren't due to steady-state operating issues such as startup yield issues. These could be caused by some of the same reasons as Process Defects, but could also be due to startup / warm-up procedures that aren't followed properly. It can also come from setup issue arising from changeovers.

IoT analytics can help reduce these productivity losses by providing visibility to production and identifying issues. Analytics can find trends and anomalies and uncover root causes so that the plant can dial in the production processes quickly to get to quality, steady state operation to optimize quality production.

16%

Stanley Black and Decker's Reynosa plant decreased their defects decreased by 16%⁵

15%

Conservative estimate for improving Availability with IIoT & analytics is 20%

Pulling it Together to Calculate Potential OEE Improvement

OEE Improvement Example

The prior sections shared potential improvements based on metrics from current research and case studies. Now it's time to show how these IoT analytics improvements come together to improve OEE.

Industry benchmarks for OEE are typically 85%, although it's mostly valuable as a way to measure opportunity and improvement for an individual company. It's important to recognize that every percentage adds to plant productivity and the bottom line.

METRIC	ORIGINAL	CONSERVATIVE IMPROVEMENT	RESULTS FROM IOT ANALYTICS
Availability	81%	20%	97%
Performance	85%	15%	98%
Quality	80%	15%	92%
OEE (A x P x Q)	55%		87%

OEE Improvement Results

It's important to note that this savings goes straight to the bottom line and can dramatically improve profitability. Clearly the impact of an additional \$61.4 million in profits to a \$500 million company would be game changing. Note that each of these metrics are improved dramatically and it would be difficult to improve all of these values simultaneously, but just improving Availability by 20% would result in over a \$20 million dollar savings. While each company's opportunity varies, the potential improvements are significant and provide a major competitive advantage.

\$500 MM
Revenue



\$190 MM
Manufacturing Cost



32%
OEE Improvement



\$62 MM
Savings from IoT
Analytics



Improve Analytics ROI by Reducing Cost of Ownership

The Cost Components of IoT Analytics ROI

So far, we've discussed how to get value by improving OEE, but the benefits obviously need to be weighed against the program costs in order to calculate an ROI. The cost would include the cost of the software as well as the cost to develop the analytical solutions to identify and solve high-value problems. The cost of manufacturing subject matter experts should also be included. We won't go into a detailed cost model, but it's important to bring up some ways that companies can limit total cost of ownership and get more from their investment.

Repeatability and Scalability Reduce Investment

In the past, most manufacturers have treated analytics projects as one-off initiatives. They have invested in developing or procuring specialty analytics focused on a single problem like improving production quality, increasing process yield, or predictive maintenance. Getting the maximum benefit for the least cost requires a more scalable, repeatable approach than investing in solutions designed exclusively to address one issue.

A Platform Approach Reduces Cost

Taking a platform approach to IoT analytics creates applications built around common data, dashboards, alerts, and algorithms. Applications built on a platform can be expanded to create more value-added solutions, providing greater value than niche solutions. Platforms

should also provide templates to help companies gather information, apply analytics, and put it to use in dashboards and alerts. Companies shouldn't have to start any of it from scratch, and over time should be able to grow on their own solutions as a foundation. For example, they can leverage an existing application by scaling it to new plants or geographies or to address other problems.

Enable Continuous Productivity Improvement

With a platform, continuous improvement teams aren't limited to solving only one kind of problem. Teams can focus on the next biggest improvement opportunity, using IoT analytics to enhance existing Six Sigma or kaizen processes. An IoT platform approach allows companies to get the most out of both the investment in their analytical toolset and the critical human resources required to apply them to improve OEE.



Next Steps – Getting Started

Develop Your IoT Analytics ROI Using The OEE Framework

Whether you're trying to grow OEE from the middle of the pack or trying to eek out additional improvements to continuously approach 100%, IoT analytics is a very good option. Companies can use the framework in this eBook to estimate the business value of an IoT analytics initiative based on research and case studies, tailoring the assumptions to fit their business and adding costs to develop an ROI and justify their efforts.

Start Small and Expand

Of course it's important that companies recognize that they should start small, gain tangible value, and create a foundation to expand on. Early projects should be valuable and measurable with tangible business results, not just technical proofs of concept. They should identify and prioritize opportunities in the plant based on the ability to improve OEE. For example, they can use IoT analytics reduce equipment downtime for a problem workcell or improve yield for a challenging product. At the same time, they should keep costs low and set the foundation for the future by using a scalable, platform-based approach.

Get Started

It's time to improve productivity by reducing the 6 Big Losses of OEE and driving improvements to Availability,

Performance, and Quality. Pick a project and scale up the value by extending to new products, production lines, plants, or geographies. It's time for manufacturing to drive meaningful change with IoT analytics and set the stage for future improvements beyond the plant. Remember, a small improvement to OEE can drive significant bottom line results, and the foundation created by Manufacturing can open up new business models and revenue opportunities across the business.

CASE IN POINT

Stanley Black and Decker's Reynosa plant improved their operating performance with the Industrial Internet of Things. OEE increased 24%, defects decreased 16%, labor utilization is up from 80 to 92%, and line throughput is up 10%.⁵

References

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- ⁴ [Making Maintenance Smarter](#) - Deloitte Insights
- ⁵ [Industrial IOT / Industrie 4.0 Viewpoints](#) - ARC



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Improving Manufacturing Performance: With IoT Analytics

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About the Author

Jim Brown is the President of Tech-Clarity, an independent research and consulting firm that specializes in analyzing the business value of software technology and services. Jim has over 20 years of experience in software for the manufacturing industries. He has a broad background including roles in industry, management consulting, the software industry, and research.

Jim's experience spans enterprise applications including PLM, ERP, quality management, service lifecycle management, manufacturing, supply chain management, and more. Jim is passionate about improving product innovation, product development, and engineering performance through digitalization and the intelligent use of software technology.

Jim is an experienced researcher, author, and public speaker and enjoys the opportunity to speak at conferences or anywhere he can engage with people with a passion to improve business performance through software technology.

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