# Measuring Success & ROI

## Defining key performance indicators (KPIs) to measure the impact of smart factory implementation

In the realm of smart factory implementation and the integration of modern IT systems, measuring success and return on investment (ROI) plays a pivotal role in determining the effectiveness and value of these initiatives. **Defining key performance indicators (KPIs) provides organisations with tangible metrics** to assess the impact of their smart factory endeavors. Some examples of KPIs in this context include production throughput, machine downtime, quality metrics, and energy consumption. By monitoring **production throughput**, companies can evaluate the efficiency and speed at which products are manufactured, ensuring optimal utilization of resources and minimizing bottlenecks. Tracking **machine downtime** helps identify opportunities for maintenance optimization, reducing costly production interruptions. **Quality metrics** enable organisations to measure product defects, rework, and customer satisfaction, thereby ensuring the delivery of high-quality products. Lastly, monitoring **energy consumption** helps identify energy-saving opportunities, leading to cost reduction and environmental sustainability. By defining and analysing these KPIs, businesses can gain valuable insights into the success and ROI of their smart factory implementation, driving continuous improvement and growth.

It is important to note that the specific **KPIs and metrics used to measure the success and ROI of smart factory implementation can vary** depending on the unique characteristics of each factory and the specific IT systems being adopted. Factors such as the industry, product type, production processes, and customer requirements all play a crucial role in determining the relevant KPIs for a given scenario. For example, a factory focused on lean manufacturing might prioritize metrics such as lead time reduction, inventory turnover, and waste reduction. On the other hand, a factory with a strong emphasis on customer responsiveness might prioritize KPIs related to on-time delivery, order fulfillment accuracy, and customer satisfaction ratings. By tailoring the selection of KPIs to align with the specific objectives and requirements of the factory, organisations can ensure a comprehensive evaluation of the impact and success of their smart factory implementation.


# Case Study: **Implementing ANT OEE Monitoring Solution in Measurement and Control Instruments Factory.**

Analysing data and evaluating the Return on Investment (ROI) of smart factory solutions on example of quality, availabilty and quality factors

In the era of Industry 4.0, smart factory solutions are transforming manufacturing landscapes, driving efficiency, and enhancing productivity. However, understanding the return on investment (ROI) of these solutions is crucial for businesses to justify the initial expenditure and ongoing costs. **This chapter based on real collected data delves into the analysis of data and evaluation of ROI for basic MES system implemented by ANT Solutions, focusing on the critical factors of quality, availability, and performance in a measurement devices factory setting.** By examining real-world examples, we aim to provide a comprehensive understanding of how advanced technologies can significantly impact the bottom line and foster a more sustainable and profitable manufacturing environment.

# Availability

## **Comparative presentation of machine data:**
## machine availability - injection molding machines

| Machine | Availability August 2022(%) (before ANT System implementation) | Availability November 2022(%) (after ANT System implementation) |
|---|---|---|
| 004151_*****_*****_**** | 62.79 | 90.59 |
| 004176_*****_*****_**** | 49.37 | 88.23 |
| 004103_*****_*****_**** | 17.82 | 84.71 |
| 001522_*****_*****_**** | 38.35 | 83.64 |
| 001728_*****_*****_**** | 31.09 | 83.46 |
| 002336_*****_*****_**** | 62.58 | 79.90 |
| 004177_*****_*****_**** | 69.32 | 77.76 |
| 004152_*****_*****_**** | 49.33 | 73.09 |
| 002348_*****_*****_**** | 34.93 | 70.70 |
| 004104_*****_*****_**** | 54.71 | 69.83 |
| 002208_*****_*****_**** | 66.27 | 70.41 |
| 004865_*****_*****_**** | 82.10 | 66.36 |
| 001685_*****_*****_**** | 39.16 | 63.28 |
| 003114_*****_*****_**** | 43.17 | 60.67 |
| 004178_*****_*****_**** | 49.99 | 60.67 |
| **Average efficiency for injection molding machines in %** | **50.06** | **76.34** |

Data from the ANT MES system shows that in the month of November this year, a significant item that may have an impact on reduced machine availability are the highest share machine stocks, such as:

- Lack of production plan - this condition accounted for as much as **19.84%** - making a total of 1921h 52m - so, nearly **20%** of the machines were not working, due to the lack of production orders.
- Lack of operator - this condition accounted for **4.88%** - totalling 472h 57m - meaning that the injection moulding machines were not working to this extent due to a lack of staffing. This is an improvement on the figure for August this year, which was **12.56%**.
- Changeover - **4.64%**, i.e. 449h required for machine changeover. This is also an improvement on the figure for August, which was **9.13%**.
- Unplanned downtime - represents **3.15 %** - which means that operators did not work and did not log the status on the machine. This indicator has improved, by as much as **4.98%**, over the three months.
- The table above details the proportion of all other states that have been logged on machines - for further analysis.

Loss of machine availability is influenced by events such as unplanned downtime or those planned, e.g. maintenance, which can show that there has been a significant improvement in unplanned machine downtime over the last three months.

## Performance

## Comparative presentation of machine data:

machine performance - injection molding machines

| Machine | Performance August 2022(%) (before ANT System implementation) | Performance November 2022(%) (after ANT System implementation) |
|---|---|---|
| 004152_*****_*****_**** | 56.48 | 96.25 |
| 004104_*****_*****_**** | 56.28 | 94.68 |
| 004176_*****_*****_**** | 40.84 | 91.44 |
| 004177_*****_*****_**** | 22.13 | 90.28 |
| 002208_*****_*****_**** | 33.44 | 89.77 |
| 002348_*****_*****_**** | 19.94 | 87.93 |
| 004151_*****_*****_**** | 15.19 | 87.83 |
| 004103_*****_*****_**** | 45.24 | 86.74 |
| 001522_*****_*****_**** | 30.70 | 85.53 |
| 004865_*****_*****_**** | 1.38 | 85.48 |
| 001685_*****_*****_**** | 38.48 | 83.24 |
| 002336_*****_*****_**** | 65.04 | 78.86 |
| 001728_*****_*****_**** | 65.62 | 77.85 |
| 004178_*****_*****_**** | 37.66 | 75.76 |
| 003114_*****_*****_**** | 62.45 | 73.91 |
| **Average performance for injection molding machines in %** | **39.39** | **85.70** |

A marked reduction in the level of discrepancy in the performance of individual injection molding machines over the analysed period from **96.25%** for the injection molding machine with the highest productivity (004152) to **73.91%** for the one with the lowest productivity (003114) - compared to the previous period covered by the analysis 3 months back, i.e. August this year, where the highest recorded productivity of the machine was 65.62% and the lowest productivity rate was **1.38%**.

The above data indicates that it is likely that one of the reasons for the significant improvement in productivity on the machines may be the clearing of orders by operators, which in earlier periods were probably not cleared.

# Quality

## Comparative presentation of machine data:

machine quality - injection molding machines

data for the period: **November 2022**

| Machine | Production (pcs.) | Defects (pcs.) | Quality (%) |
|---|---|---|---|
| 004177_*****_*****_**** | 306372 | 0 | 100 |
| 004152_*****_*****_**** | 247161 | 143 | 99.94 |
| 004178_*****_*****_**** | 241116 | 0 | 100 |
| 004151_*****_*****_**** | 226799 | 10 | 100 |
| 004176_*****_*****_**** | 146704 | 0 | 100 |
| 001522_*****_*****_**** | 145195 | 0 | 100 |
| 001728_*****_*****_**** | 126458 | 0 | 100 |
| 002348_*****_*****_**** | 107579 | 0 | 100 |
| 002336_*****_*****_**** | 49208 | 0 | 100 |
| 004103_*****_*****_**** | 48307 | 16 | 99.97 |
| 004104_*****_*****_**** | 36390 | 6 | 99.98 |
| 004865_*****_*****_**** | 36028 | 142 | 99.61 |
| 001685_*****_*****_**** | 34524 | 0 | 100 |
| 003114_*****_*****_**** | 29078 | 0 | 100 |
| 002208_*****_*****_**** | 16131 | 0 | 100 |
| | **1 797 050.00** | **317** | **99,97** |

Comparing the data with the previous analysis period, i.e. the month of July this year, there was a significant decrease in the number of defects with an increase in the number of units produced.

***In the month of July** this year, with a total production of **864,909** units, there were **1 011 defects**, while **in month of November** this year, with a total production of **1 797 050 pieces**, **317 defects** were registered.*

# OEE Overall

## Comparative presentation of machine data:
machine OEE - injection molding machines

data in the table for the period: **November 2022**

| Machine | OEE (%) |
|---|---|
| 004176_*****_*****_**** | 80.96 |
| 004151_*****_*****_**** | 79.71 |
| 004152_*****_*****_**** | 75.37 |
| 004103_*****_*****_**** | 73.20 |
| 004177_*****_*****_**** | 71.94 |
| 001522_*****_*****_**** | 71.06 |
| 002336_*****_*****_**** | 66.20 |
| 002348_*****_*****_**** | 64.95 |
| 001728_*****_*****_**** | 64.39 |
| 002208_*****_*****_**** | 63.15 |
| 004865_*****_*****_**** | 59.45 |
| 004104_*****_*****_**** | 58.71 |
| 001685_*****_*****_**** | 55.98 |
| 003114_*****_*****_**** | 49.35 |
| 004178_*****_*****_**** | 40.68 |
| **Average OEE score in %** | **65.01** |

**The average OEE value in July**
(before ANT System implementation)

**31.82%**

**The average OEE value in November**
(after ANT System implementation)

**65.01%**

Analysis of the OEE indicator for injection moulding machines indicates.

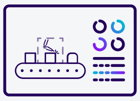
A significant improvement in the value of the OEE indicator compared to the last analysis period.

***The average OEE value in the month of July*** *this year* ***was 31.82%,*** *the average current value of the index* ***in the month of November is 65.01%****.*

# Case Study: **Conclusions**

Based on the OEE Waterfall chart or Pareto Chart, a manager can describe what causes the OEE drops or where to look for improvements.

## IDENTIFIED KEY AREAS for optimalisation

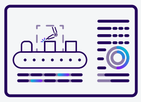


### Machine availability

Analysis of the reasons for low machine availability - no production plan, no operator, changeovers, unplanned downtime.

### Lack of production plan

This accounts for nearly 20% of all machine downtime - this provides an opportunity to increase machine engagement by reviewing orders imported onto the machines, possibly considering ways to win new production orders (new customers, hire etc.).

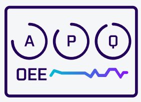


### Lack of supervision

The operator may not actively monitor the injection molding machine, leading to delayed detection of issues such as mold sticking, mechanical failures, or leaks. Unnoticed problems can result in longer downtimes and lower efficiency.

### Operators' work

Despite the downward trend, there are still unplanned downtimes on machines, extra breaks, and the changeover rate is also high.




### Machine performance

Analysis of the reasons for low performance when a machine is available - e.g. operators not clearing orders.

Based on the following data, factories can **easily calculate the return on investment (ROI)** based on their individual case. Each manufacturing line and plant is unique, possessing its own set of variables and operational characteristics that influence the outcomes of digital transformation.

improve

**OEE**

for all machines, prioritising those with the lowest OEE - aiming for an OEE of min. **85%.**

By carefully analysing key metrics, such as increased productivity, reduced downtime, improved quality, and streamlined processes, organisations can quantify the impact of their digital initiatives and make informed decisions regarding resource allocation and future investments. It is through this tailored approach that factories can unleash their true potential and realize significant returns on their digital transformation endeavors.