Overall Equipment Effectiveness (OEE) Analysis

Effectiveness and efficiency are the primary metrics for measuring productivity in today's industrial sector. Efficiency and effectiveness in the manufacturing industry depend on how readily available and productive a manufacturing facility is.

For this to happen, improving and optimising productivity is the basic necessity. It involves both looking for and removing redundant production losses. Overall, it contributes to product cost reduction, competitiveness, and meeting consumer demand.

For the question 'How can a manufacturing organisation improve their efficiency and effectiveness?' Analysing the industry's **Overall Equipment Effectiveness (OEE)** is the solution.

Overall Equipment Effectiveness (OEE) analysis, a key metric in **Total Productive Maintenance (TPM)** and **Lean Manufacturing** programs. It helps to monitor and improve the efficiency and effectiveness of a manufacturing industry.

OEE takes the most common and important sources of manufacturing productivity loss and places them into three primary categories: **availability, performance,** and **quality.** Each of these factors gets you the idea on how close your manufacturing process is to near perfection.

Objective: Using Infoveave to

- Analyse the Overall Equipment Effectiveness (OEE).

Introduction

OEE (Overall Equipment Effectiveness) is a tool used to assess the success of TPM (Total Productive Maintenance). Three factors—availability, performance, and quality—are multiplied to get OEE. Its unique feature is that hidden losses are taken into account to boost the relevance of equipment use.

OEE is derived by the multiplication of three manufacturing productivity loss categories **availability, performance,** and **quality**. It provides a much richer understanding of wastage in the manufacturing process.

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

Availability is the ratio between the uptime (runtime) and the planned production time (or scheduled time) and is calculated as:

$$Availability = \frac{Uptime}{Planned\ Production\ Time}$$

$$Uptime = Planned\ Production\ Time - Downtime$$

$$Downtime = Scheduled\ Breaktime + Unplanned\ Shutdowns + Changeover\ Time$$

$$Changeover\ Time = New\ run\ start\ time\ -\ Current\ run\ end\ time$$

Performance gives insight into the efficiency of the line to produce products at the constant rate.

$$Performance = \frac{(Ideal\ Cycle\ Time\ \mathrm{x}\ Total\ Count)}{Uptime}$$

$$Total\ Count = Good\ Count + Rework\ Count + Rejected\ Count$$

$$Rejected\ Count = Total\ Count — (Good\ Count + Rework\ Count)$$

Quality is the percentage of items that pass the first quality inspection.

$$First\ Time\ Yeild = \frac{(Good\ Count + Rework\ Count)}{Total\ Count}$$

First Time Yield (FYT) is the percentage of items that pass the first inspection.

$$Quality = \frac{Good\ Count}{Total\ Count}$$

Ideal Cycle Time is the best and the fastest time to create one single finished product.

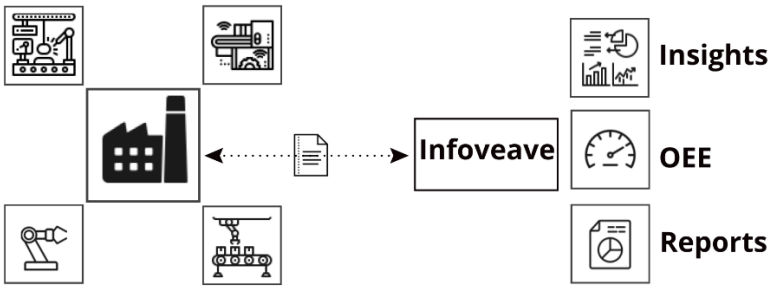
$$Ideal\ time = Process\ time + Inspection\ time + Movement\ time + Queue\ time\ (per\ product)$$

Terminologies

Terminology	Definition
Planned Production Time	The total time that the production asset is scheduled for production.
Uptime	The time for which the machine actually runs.
Downtime	The time for which the machine was not working.
Scheduled Breaktime	Scheduled machine shutdowns (includes scheduled breaks and machine repairs and services).
Unplanned Shutdowns	Machine/Production shutdown over unpredicted events (includes power outrage and machine breakdown).
Changeover Time	Occurs between the last product of the previous lot and the first product of the next lot.
Good Count	Number of good products produced
Rework Count	Number of products that can be accepted over small reworks.
Rejected Counts	Total number of rejected products.
Total Count	Total number of products produced.

This solution accelerator looks at how to use Infoveave to analyse overall equipment effectiveness (OEE) and determine first time through (FTT).

Workflow Chart



Step 1: Factory Data Table Configuration

To estimate the OEE, we need to derive several other metrics. It's important to note that when calculating metrics, we need to consider when our dataset terminates. Calculating these metrics relative to production date will lead to estimate the uptime, downtime availability, performance, quality, OEE, and FTT. To get started with these calculations, let's take a look at how they are performed. The data in the workbook are organized as a range in the production facility spreadsheet. Each record represents a line item in the production facility. We use a power tool manufacturing facility to describe the process.

Note: The process and the datasource highlighted are in focus for the power tool manufacturing facility. You need to make the necessary modifications according to the requirements.

Factory Production Data:

We can use the given template for configuring the data table. The template consists of all the necessary fields, for the OEE estimation.

Factory Production Data sample template

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Date	Product Group	Line Name	Model Name	Ideal Time (Seconds)	Planned Production Quantity	Serial From	Serial To	Shift Slot	Shift Runner	Available Time (Minutes)	Good Part Qty	Rework Qty	Rejection Qty	FTT Defect Qunatity	Manpower	Unplanned Shutdowns (Minutes)	Shutdown Reasons	Changeover Time (Minutes)	Remarks
07-07-2022 00:00	Hand Tool	Hammer	HM00641	120	300	32870	33170	I	Mathew	465	100	20	10	10	12	0	NA	20	OK
07-07-2022 00:00	Fastener Tools	Nut	N409979	240	450	32390	32840	II	John	465	300	20	20	6	13	10	Machine Stuck	40	OK
07-07-2022 00:00	Power Tool	Jointer	J9876	300	250	32390	32640	III	Suresh	465	100	12	30	0	13	0	NA	20	Material Shortage
08-07-2022 00:00	Hand Tool	Hammer	HM00642	300	120	30299	30419	I	Kevin	465	300	10	3	26	15	0	NA	15	Material Shortage

The fields included in the dataset are:

Sl. No.	Column Fields	Descriptions	Data Type
1	Date of Production	Production date and time, at the factory. Date of Production is represented in the format: {DD-MM-YYYY HH:MM:SS} Example: 08-07-2022 00:00:00	DateTime
2	Product Group	Product category that the items fall within. Example: Hand tools For instance, the product category Hand Tools includes goods like wrenches, pliers, cutters, hammers, and screwdrivers.	String
3	Line Name	Name of the product being manufactured. Examples include screwdrivers, pliers, cutters, hammers, and wrenches.	String
4	Model Name	Alphanumeric uniquely assigned to each model. For instance, under hammers come the different models and types like wooden hammers, iron hammers, short-handled hammers, or long-handled hammers. Example: Model name HM00641 represents wooden hammer.	String
5	Ideal Time	The theoretically fastest possible time to manufacture one piece.	Time
6	Planned Production Quantity	The number products planned for the shift	Numeric
7	Shift Runner	Name(s) of the shift supervisor (s).	String
7	Serial From	Production start serial code for each model.	Numeric
9	Serial To	Production end serial code for each model.	Numeric
10	Shift Slot	Preassigned shifts. A manufacturing facility has three shifts, each lasting eight hours. **Shift 1** (8.00am – 4.00pm), **Shift 2** (4.00pm-12.00am), and **Shift 3** (12.00am to 8.00am)	Numeric
11	Available Time	The actual period of time that employees will work during the planned production period.	Numeric
12	Good Part Qty	Amount of quality items produced	Numeric

Sl. No.	Column Fields	Descriptions	Data Type
13	Rework Qty	The quantity of manufactured goods that need to be reworked.	Numeric
14	Rejection Qty	Total products rejected	Numeric
15	FTT defect Quantity	First time through defect quantity	Numeric
16	Manpower	Number of working personals	Numeric
17	Unplanned Shutdowns	Production halt duration over undefined reason	Numeric
18	Shutdown Reasons	Reasons for shutting the production line	String
19	Changeover Time	Time elapsed between the final item on the last production run and the next item on the new run	Numeric
20	Remark	Comments on the product lines that have been manufactured.	String

The fields that are most relevant to our work are the ones to identify the uptime (operational hours), the downtime (non-productive hours), availability, performance, quality, OEE, and FTT based on the equations.

Note: You are welcome to utilise our data template to generate the **Factory Production Table**. You can modify our data table template to meet your specific requirements.

Product Group Data:

The product group data identifies the product group in the manufacturing facility. Over a power tool manufacturing facility, the main product groups identified are Hand Tool, Power Tool, Fastener Tool, and Measure Tool.

Note: You are encouraged to formulate your own product group data.

Product Group Data sample template

	A	B
1	Product Group_L0	
2	Hand Tool	
3	Power Tool	
4	Fastener Tool	
5	Measure tool	

Production Line Data:

The data on the line describes the model and type of product being manufactured in that line (The production line data shows the type of products manufactured by the facility under each product group).

Note: The product line data is specific to the product type.

Product Line Data sample template

	A	B
1	**Product Group_L1**	**Model Line Name_L0**
2	Power Tool	Drill
3	Power Tool	Jointer
4	Power Tool	Router
5	Power Tool	Drill
6	Hand Tool	Hammer
7	Hand Tool	Wrench
8	Hand Tool	Hand Saw
9	Hand Tool	Screwdriver
10	Hand Tool	Hammer
11	Fastener Tool	Bolt
12	Fastener Tool	Nut
13	Measure Tool	Caliper
14	Measure Tool	Micrometer

Production Model Data:

Production model data specifies the product's model number along with the specifications of the product group and line name.

Product Model Data sample template

	A	B	C
1	**Product Group_L2**	**Model Line Name_L1**	**Model_L0**
2	Power Tool	Drill	DW00718-AE
3	Power Tool	Heat Gun	SXH1800-IN
4	Hand Tool	Axe	54-105
5	Hand Tool	Plier	CN00193
6	Fastener Tools	Bolt	DH212
7	Fastener Tools	Bolt	DH212
8	Measure tool	Micrometer	M984345
9	Measure tool	Micrometer	M984345
10	Measure tool	Caliper	STHT36127-812
11	Measure tool	Caliper	STHT36127-812

According to your needs, you can construct datasets on shift slots, shift timings, FTT defect reasons, and downtime reasons.

Step 2: Configurating the Datasource in Infoveave

Factory Production Datasource

With the factory data table set configured, we can rely on Infoveave for the easy updates, data Insights, OEE & FTT estimation. Primarily, we need to use the Factory Production Data table to create a master production datasource 'Factory Production Data' in Infoveave. To understand on creating a datasource in Infoveave, read through the Infoveave documentation on Creating a File based Datasource.

Factory Production Master Datasource

Configuring a Production Master datasource in Infoveave is the next step. To setup the Factory Production Master Datasource, follow the steps below.

1. Create a file based datasource in Infoveave with the Product Group Dataset.
2. In the cube designer use the 'Add File' option to add the Production Line and model tables.

Shift Master Datasource

A shift master datasource need to be created. To formulate a shift master datasource

1. Create a file based datasource in Infoveave on Shift Slot dataset.
2. Use the Add file option to add the shift timing tables to the datasource

Note: Three different data ingestion techniques are available from Infoveave: incremental, truncate & reload, and upload. Pick the right data ingestion method when building your data source in Infoveave. The Data Upload and Data Ingestion in Infoveave help, can teach you more about the data ingestion techniques.

Defining the Measures and Dimensions

While configuring the datasource we need to define the measures, dimensions, calculated columns, and the calculated measures in the Infoveave cube designer. You can learn more about them from documentation on Measures and Dimensions.

The column fields to be defined as measures and dimensions in general are.

Measures	Dimensions
Good Part Qty	Production Date
Rejection Qty	Product Group
Available Time	Line Name
Rework Qty	Model
FTT Defect Qty	Shift Slot
Credit Time	Operator Name
Manpower	Serial From
	Serial To

Note: You can define columns fields as measures and dimensions as per your requirements

Calculated Columns

The extra columns that Infoveave creates from the existing columns using mathematical operations are known as calculated columns. The calculated columns to be defined for the factory production datasource are

Calculated Columns	Formula
Total Produced Qty	`@Good Part Qty + @Rework Qty + @Rejection Qty`
Total Actual Credit Time	`((((( @Available Time- @Total Downtime) / ( @Good Part Qty + @Rework Qty + @Rejection Qty ) ) * @ Manpower) * 60 ).toFixed(2))`
Performance	`(((((((( @Ideal Time /60)/ @Manpower )) * ( @Good Part Qty + @Rework Qty + @Rejection Qty )).toFixed(2))/ ( @Available Time - @Total Downtime )).toFixed(2))`
Uptime	`@Available Time - @Total Downtime`

Down time	`Scheduled Breaktime + @Unplanned Shutdowns + @Changeover Time`
Production Plan	`(((@Available Time*60)/@Ideal Time)*@Manpower).toFixed(2)`

Calculated Measures

Calculated measures are those defined mathematically, based on the calculated columns. The calculated measurements that must be defined in the factory production data source are

Calculated Measure		Formula
OK Qty	[Measures].[OK Qty]	[Measures].[Good Part Qty] +[Measures].[Rework Qty] +[Measures].[Rejection Qty] - [Measures].[FTT Defect Qty]
PPM	[Measures].[PPM]	(([Measures].[Rework Qty]+[Measures].[Rejection Qty])/[Measures].[Produced Qty]) * 1000000
Availability	[Measures].[Availability]	[Measures].[Uptime] / [Measures].[Available Time]
Output per Employee	[Measures].[Output per Employee]	[Measures].[Produced Qty]/[Measures].[Manpower]
Efficiency	[Measures].[Efficiency]	[Measures].[Credit Time] / [Measures].[Total Actual Credit Time]
FTT	[Measures].[FTT]	[Measures].[Good Part Qty] / [Measures].[Produced Qty]
OEE	[Measures].[OEE]	[Measures].[Availability] * [Measures].[FTT] * ([Measures].[Avg Performance])
Actual Credit Time	[Measures].[Actual Credit Time]	[Measures].[Uptime]/[Measures].[Produced Qty]*[Measures].[Man Power]*60

For additional information on calculated columns and calculated measures, read Datasource Advanced Features.

Step 3: Setup NGuage Forms

With the datasources created, we now create NGuage forms for daily updates on the production data in Infoveave. NGauge Forms are your interface with any file-based datasource in Infoveave. Any file-based datasource in Infoveave can have its records updated using NGuage forms. Using NGuage forms, you can update or edit the table in a file-based datasource.

To understand how to create NGuage Forms using the prepared datasources, read the NGuage Forms documentation.

You can follow the steps while creating the NGuage forms.

1. Select the product group data table from the factory production master datasource to formulate the NGuage forms on product groups.
2. Similarly use the other available tables in the factory production master datasource to create NGuage on product line and product model.

Note: You must check the Master Datasource checkbox while constructing the above stated NGuage forms.

3. Create NGuage forms on the Factory Production Dataset.
    a. For those that require the fields to be taken from master datasource, select master datasource from the “Type” dropdown.
    b. Enter the required code to call the tables.
        i. Example

```
[Product Group_L2]='Product Group' && [Model Line Name_L1]='Line Name
'.
```

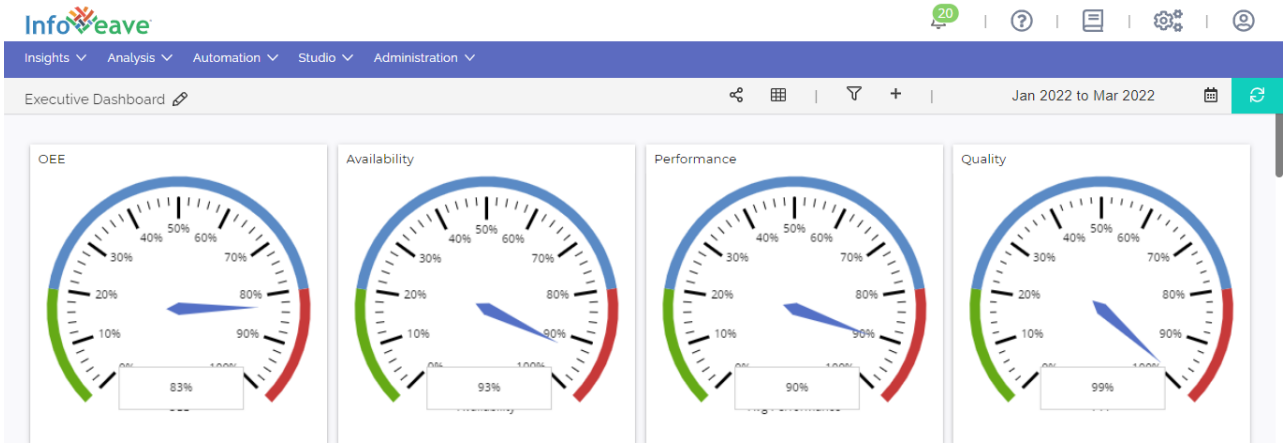
Step 4: Summary Dataset Insights

Now we update the summary dataset on the Factory Production Data that include the column filed on uptime, total downtime, Total Produced Qty, Total Actual Credit Time and Performance.

Sample summary dataset

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	Date	Product Group	Line Name	Model Name	Ideal Time (Secon	Planned Production	Serial From	Serial To	Shift Slot	Shift Runner	Available Time (Minutes)	Good Part Qty	Rework Qty	Rejection Qty	FTT Defect Qty	Manpower	Unplanned Shutdow	Shutdown Reasons	Changeover Time	Remarks	Total Produced Qty	Uptime	Total Down time	Total Actual Credit	Performance
2	07-07-2022 00:00	Hand Tool	Hammer	HM00641	120	300	32870	33170	I	Mathew	465	100	20	10	10	12	0	NA	20	OK	130	420	45	238.46	0.72
3	07-07-2022 00:00	Fastener Tools	Nut	N40997 9	240	450	32390	32840	II	John	465	300	20	20	6	13	10	Machine Stuck	40	OK	340	460	5	248.24	1.35
4	07-07-2022 00:00	Power Tool	Jointer	J9876	300	250	32390	32640	III	Suresh	465	100	12	30	0	13	0	NA	20	Material Shortage	133	380	85	240.85	0.42

Use the defined measures and dimensions to create the required Infoboards in Infoveave. Use the help documentation on Create Infoboard and Create New Widgets to understand more. The widgets on the Infoboard highlights OEE, FTY, Availability, Quality and Performance. Remember to use appropriate widgets to showcase the KPIs. Example: Use the bar chart widgets to showcase the comparison between the planned credit time and the actual calculated credit time.



OEE Ranges

The theoretical OEE score of 100% is not realistic in the actual world. However, an OEE score of more than 85% is regarded as world-class. OEE scores for the majority of manufacturing processes range from 65% to 85%. Any plant with an OEE score less than 65% probably has significant deficiencies in its processes. A score of this low OEE is a red flag.

OEE score < 65 %: OEE scores below 65% show that there is much space for development because the capacity that is available isn't being used to its full potential.

OEE score between 65 % and 85 %: Implies that the manufacturing operations are in this range. In this stage, it is advisable to implement processes for automatic optimization and continual monitoring of the systems.

OEE score > 85 %: Shows the company is effectively handling the production facility.

Note: When evaluating OEE scores, it's crucial to take the type of machine and/or manufacturing method into account. For machines that run continuously, an OEE score of 90% may really be the low end, whereas for complicated industrial processes, an OEE score of 60% may already be the maximum limit.