

AVEVA PI WORLD

OPE (Overall Process Effectiveness) analytics for better performance intelligence

Optional Subtitle

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OPE (Overall Process Effectiveness) analytics for better performance intelligence

The Ecolab Clearing Plant outside Chicago, IL had plenty of sensor data but they were not structured for OPE (overall process effectiveness) or OEE (overall equipment effectiveness) analysis.

Join us for this session as we walk through how we used the PI System's function primitives and other AF/EF capabilities for data modeling and then applied the manufacturing context to raw sensor (time-series) measurements and lab quality data to prepare for OPE diagnostics. This upfront data engineering also proved to be critical for PI Vision and BI (business intelligence) displays for visual analytics.

Lastly, we will discuss the insights and business benefits we have seen so far, including the next phase in this ongoing work to incorporate machine learning (ML) for additional analytics.

Problem Statement

Munchies for the band (Van Halen) in their dressing room...





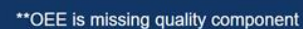
IT vis-à-vis Process Engineer

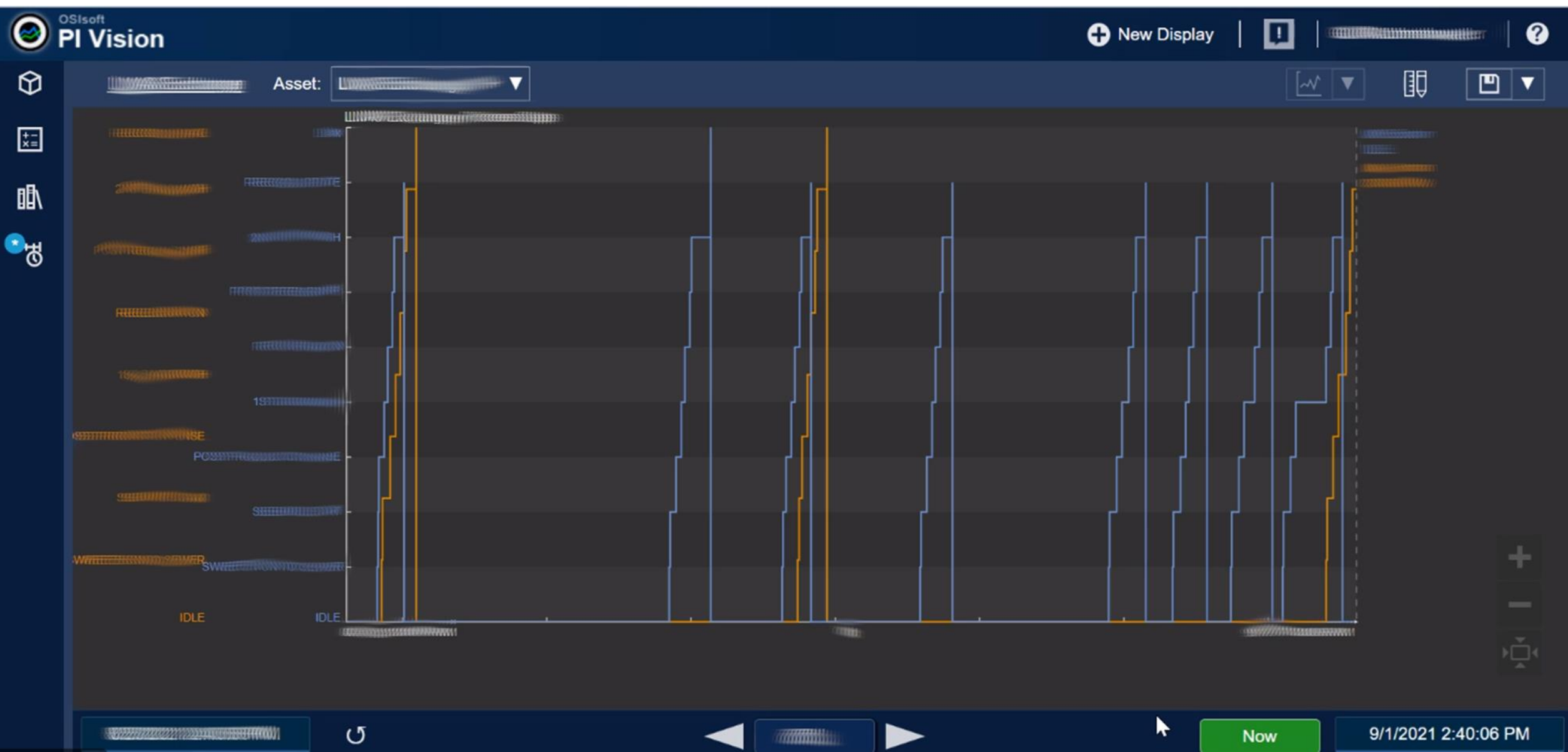
IT

... Just give me all the data, let's put it in a data lake and we'll figure it out...

Process Engineer

... Let's decompose the problem into smaller chunks – do a first-cut analysis with tools and resources we already have...





PI System Explorer

FileSearchViewGoToolsHelp

Database

Query Date

Back

Check In

Refresh

New Element

Elements

Elements

CCIX

Ecolab Supply Chain

Production Data

Reactor

Reactor

Reactor

Reactors

Ultrafilter

Ultrafilter

Ultrafilter

Ultrafilters

zzz.GlobalConfiguration

Element Searches

Elements

Search

	Name	Description
	Ecolab Supply Chain	
	zzz.GlobalConfiguration	

File
Search
View
Go
Tools
Help

Database
Query Date
Back
Check In
Refresh
New Element
New Attribute

Search Elements

Elements

- Elements
- Ecolab Supply Chain
- Production Data
 - Reactor
 - Reactor
 - Reactor
 - Reactor
 - Tank
 - Tank
 - Tank
 - Reactors
 - Ultrafilter
 - Ultrafilter
 - Tank
 - Ultrafilter
 - Ultrafilters
 - zzz.GlobalConfiguration
 - Element Searches

UF7

General
Child Elements
Attributes
Ports
Analyses
Notification Rules
Version

Excluded attributes are hidden.

Filter

Name	Value
Idle Trigger: Between Batches_IdleTrigger	1
Lowest Output Last 7 Days	34554 kg
MIN	Scan Off
Naming Prefix	BP.NAG.Grow.UF7.UF7.
OEE	5.4198 %
OPE	100 %
Permeability	0
Permeate Specific Gravity	1
Pressure: Before Bag Filter	psig
Pressure: UF Inlet	psig
Pressure: UF Outlet	psig
Process Step	Idle
Pump: UF	Not Running
Retentate Specific Gravity	1
Run Time (Control Screen)	0

Group by:
☐ Category
☐ Template

Name:
AVG Cycle time loss Per Batch (

Description:

Properties:
<None>

Categories:
Work in Progress

Default UOM:
minute

Value Type:
Single

Value:
96.113 min

Display Digits:
-5

Data Reference:
PI Point

Settings...

Limits
Forecasts

Filter

	Name	[49.08:00:30.6...	Duration	Start Time	End ...	Descri...	Categ...	Severity	Template
• ✓ ▲	Reactor Producing			8/30/2021 4:29:35.063 PM	8/30...			None	Downtime Loss Event
• ✓	Reactor Hold Time 8/30/2021 10:14:32 PM			8/30/2021 5:14:32.061 PM	8/30...			None	Process Step Duration
• ✓	Reactor Grow Template 8/30/2021 10:14:34 PM			8/30/2021 5:14:34.061 PM	8/30...			None	Process Step Duration
• ✓	Reactor Ready to Pump Out Batch 8/30/2021 11:16:54 PM		0:	8/30/2021 6:16:54.075 PM	8/30...			None	Process Step Duration
• ✓	Reactor 8/30/2021 11:18:23 PM		0:	8/30/2021 6:18:23.075 PM	8/30...			None	Process Step Duration
•	Reactor Idle 8/30/2021 11:20:52 PM			8/30/2021 6:20:52.075 PM				None	Process Step Duration
• ✓ ▲	Reactor Not Identified: Midprocess		0:04:37.997	8/30/2021 6:20:52.075 PM	8/30...			None	Downtime Loss Event
• ✓ ▲	Reactor Not Identified: Between Batches		1:13:46:34.332	8/30/2021 6:25:30.072 PM	9/1/...			None	Downtime Loss Event
• ✓	Daily Aggregated Values of Performance 2021-08-31 00:00:00.000			8/30/2021 7:00:00 PM	8/31...	This E...		None	Daily Aggregated Values o...
• ✓	Reactor			8/30/2021 7:00:00 PM	8/31...	Daily ...		None	Daily Aggregated values o...
• ✓ ▲	Reactor Waiting Loss: Tank is Empty		0:07:42	9/1/2021 8:12:04.404 AM	9/1/...			None	Downtime Loss Event
• ✓ ▲	Reactor Not Identified: Between Batches		0:00:03	9/1/2021 8:19:46.404 AM	9/1/...			None	Downtime Loss Event
• ✓ ▲	Reactor Waiting Loss: Tank is Empty		0:01:41	9/1/2021 8:19:49.404 AM	9/1/...			None	Downtime Loss Event
• ✓ ▲	Reactor Not Identified: Between Batches		0:00:15	9/1/2021 8:21:30.404 AM	9/1/...			None	Downtime Loss Event
• ✓ ▲	Reactor Waiting Loss: Tank is Empty		0:00:37	9/1/2021 8:21:45.404 AM	9/1/...			None	Downtime Loss Event
• ✓ ▲	Reactor Not Identified: Between Batches		6:03:02.075	9/1/2021 8:22:22.404 AM				None	Downtime Loss Event

Find Event Frames for 'UI'

Group by: ☐ Category ☐ Template

Filter

Name	[10.21:48:37.4...	Duration	Start Time	End ...	Descri...	Categ...	Severity	Template	Primary EK
Not Identified Midprocess		0:00:11	9/1/2021 1:16:31.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:03:54	9/1/2021 1:16:42.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:03	9/1/2021 1:20:36.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:32	9/1/2021 1:20:39.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:03	9/1/2021 1:21:11.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:03:40	9/1/2021 1:21:14.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:05	9/1/2021 1:24:54.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:06:50	9/1/2021 1:24:59.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:12	9/1/2021 1:31:49.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:44	9/1/2021 1:32:01.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:09	9/1/2021 1:32:45.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:00:30	9/1/2021 1:32:54.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:30	9/1/2021 1:33:24.034 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:14:33.999	9/1/2021 1:33:54.034 PM	9/1/...			None	Downtime Loss Event	
Not Identified Midprocess		0:00:09	9/1/2021 1:48:28.033 PM	9/1/...			None	Downtime Loss Event	
Waiting on upstream process		0:06:56	9/1/2021 1:48:37.033 PM	9/1/...			None	Downtime Loss Event	



LINKS



EXECUTIVES

PLANT ENGG

OPERATORS

GENERAL

All Unit Operations



➤ DOWNTIME



➤ CYCLE TIME

➤ OUTPUT



R -



➤ CYCLE TIME

➤ DOWNTIME

➤ OUTPUT



R -



UF -

All Unit Operation Visibility

UO Display - Control Room

Information



8/1/2021 2:33:21 PM



31d



Now

9/1/2021 2:33:21 PM

Reactor Operator Asset:

REACTOR

BREAKDOWN OF PUMPS

- Recycle Pump Breakdown - Func
- Cofeed Pump Breakdown - Func
- Overflow Pump Breakdown - Func

REACTOR DOWNTIME EVENTS

Reason Code Editor

Reactor Not Identified: Midprocess

- Breakdown - Pipe
- Breakdown - Valve
- Lack of Personnel - Meeting/Training
- Lack of Personnel - Other
- Lack of Personnel - Shift Change/Break
- Lack of Personnel - Vacation/Holiday/Illness
- Planned Downtime - Holiday
- Planned Downtime - No Orders
- Planned Maintenance
- Set up Time - Raw Materials
- Waiting Loss - QA
- Waiting Loss - Raw Materials from Supplier
- Waiting Loss - Supervisor/Engineering
- Waiting Loss - Utilities
- Waiting Loss - Weather

Clear

Apply

Cancel

REACTOR DOWNTIME EVENTS

Event Name	Start Time
Reactor Not Identified: Between Batches	9/1/2021 8:22:2
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:21:4
Reactor Not Identified: Between Batches	9/1/2021 8:21:3
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:19:4
Reactor Not Identified: Between Batches	9/1/2021 8:19:4
Reactor Waiting Loss: Tank 350 is Empty	9/1/2021 8:12:04 AM

7

352

Cycle Time Batch Duration

min

Retentate Specific Gravity

1.0000

8/1/2021 2:34:06 PM



31d

Now

9/1/2021 2:34:06 PM



Not Identified Loss

519
hrs

Waiting Loss

230
hrs

Set Up Time Loss

31
hrs

Cycle Time Loss

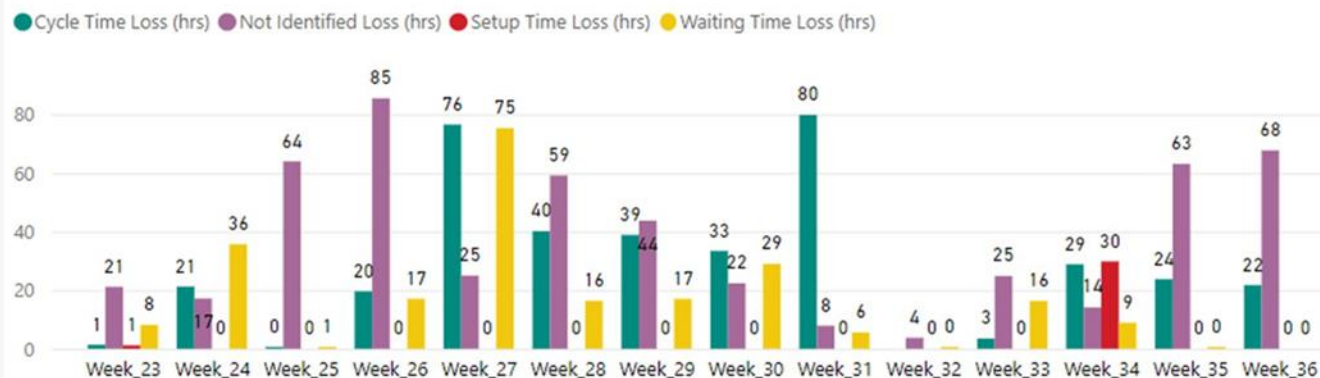
389
hrs

Unit Operation

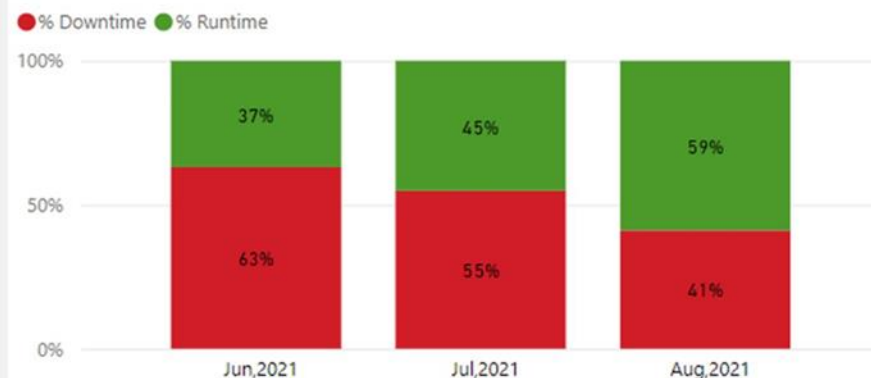
Reactor 368

Last 3 Months (...)
6/1/2021 - 8/31/2021

Downtime Loss (hrs) by week

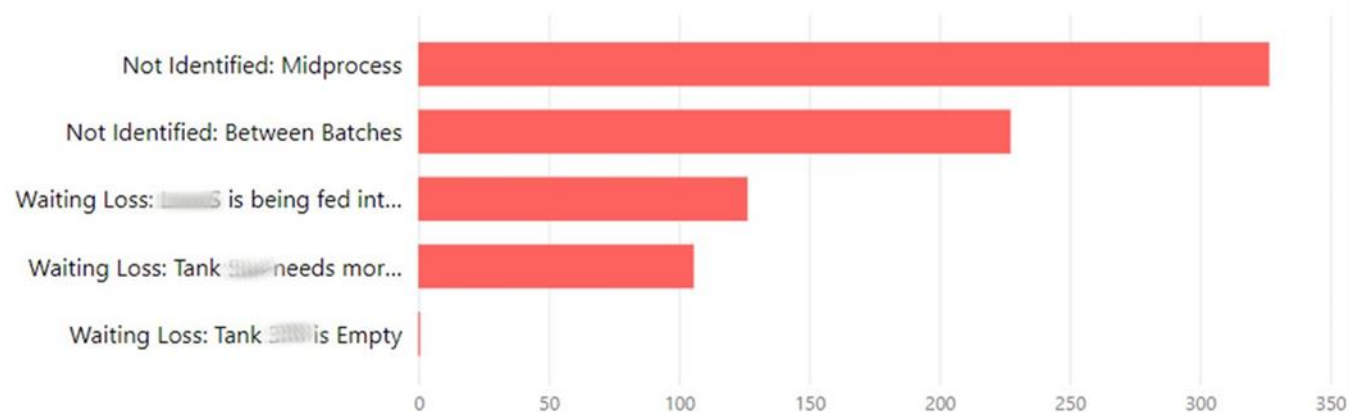


% Downtime Vs % Runtime

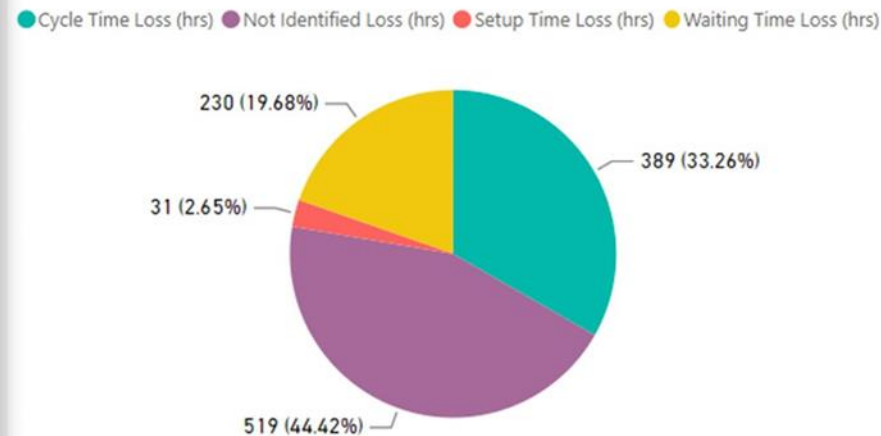


Top Reason Codes

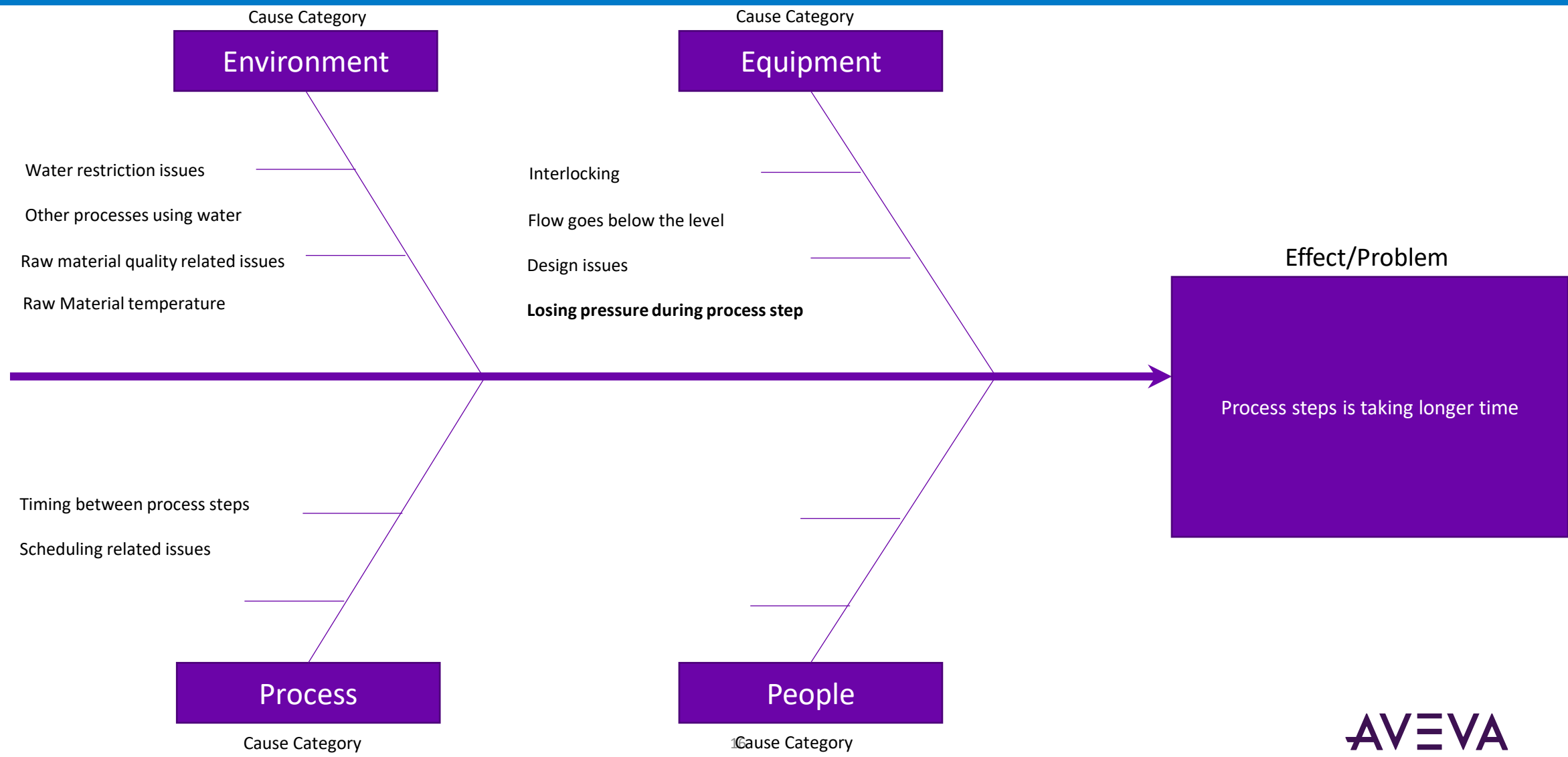
UnitOperation Reactor 368



% Loss Distribution (in hours)

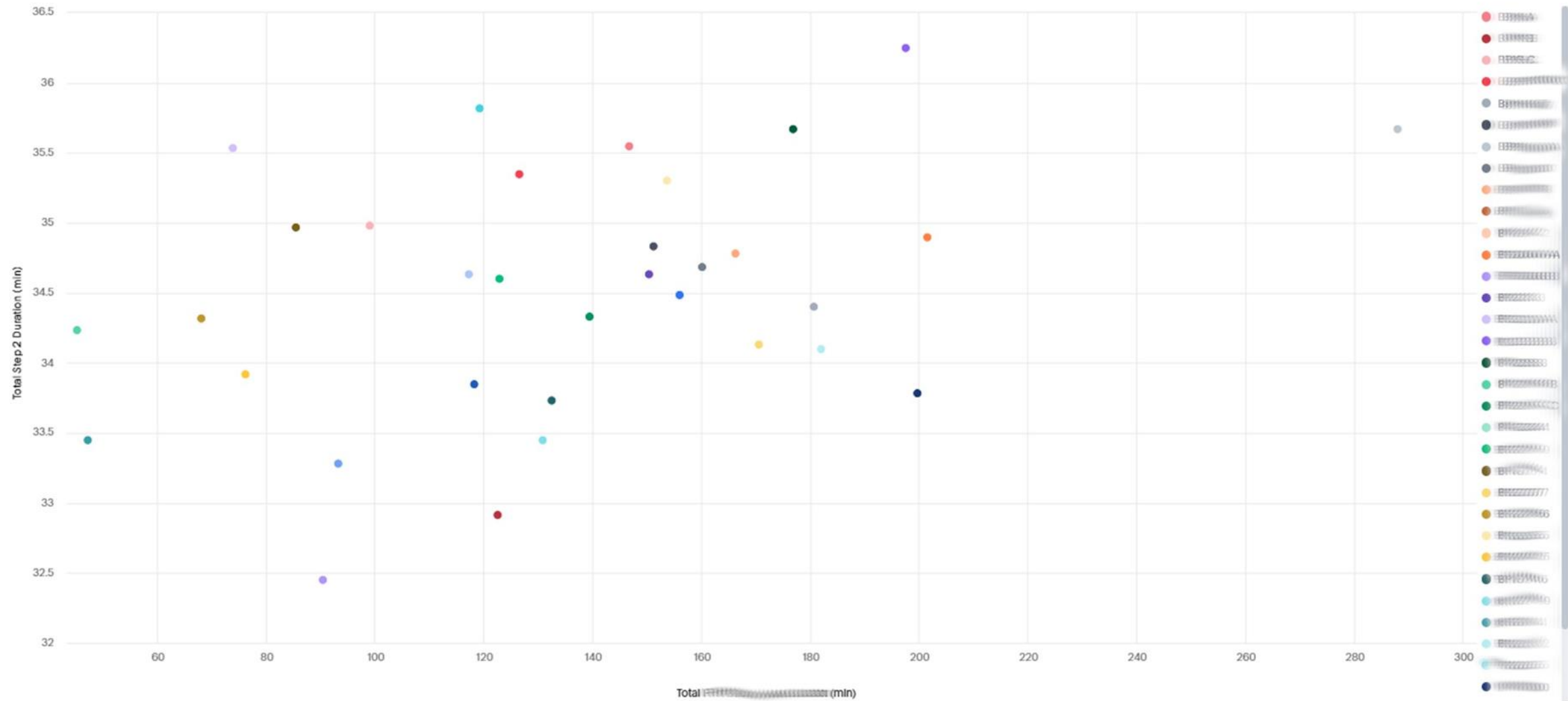


Cause and Effect

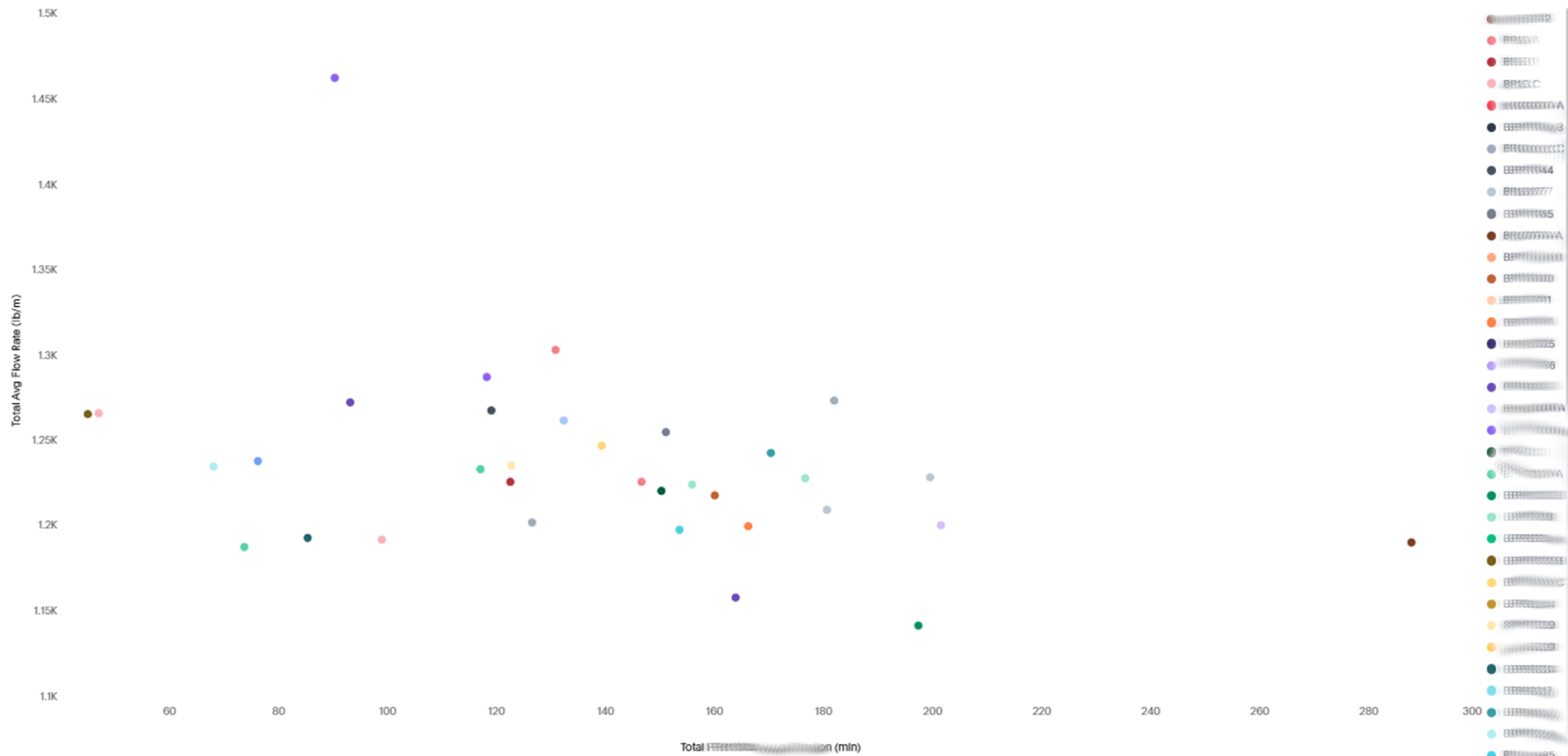


Total Step 2 Duration (min) by (min) and Batch ID

mm ... > 41



Total Avg Flow Rate (lb/m) by Total Time (min) and Batch ID



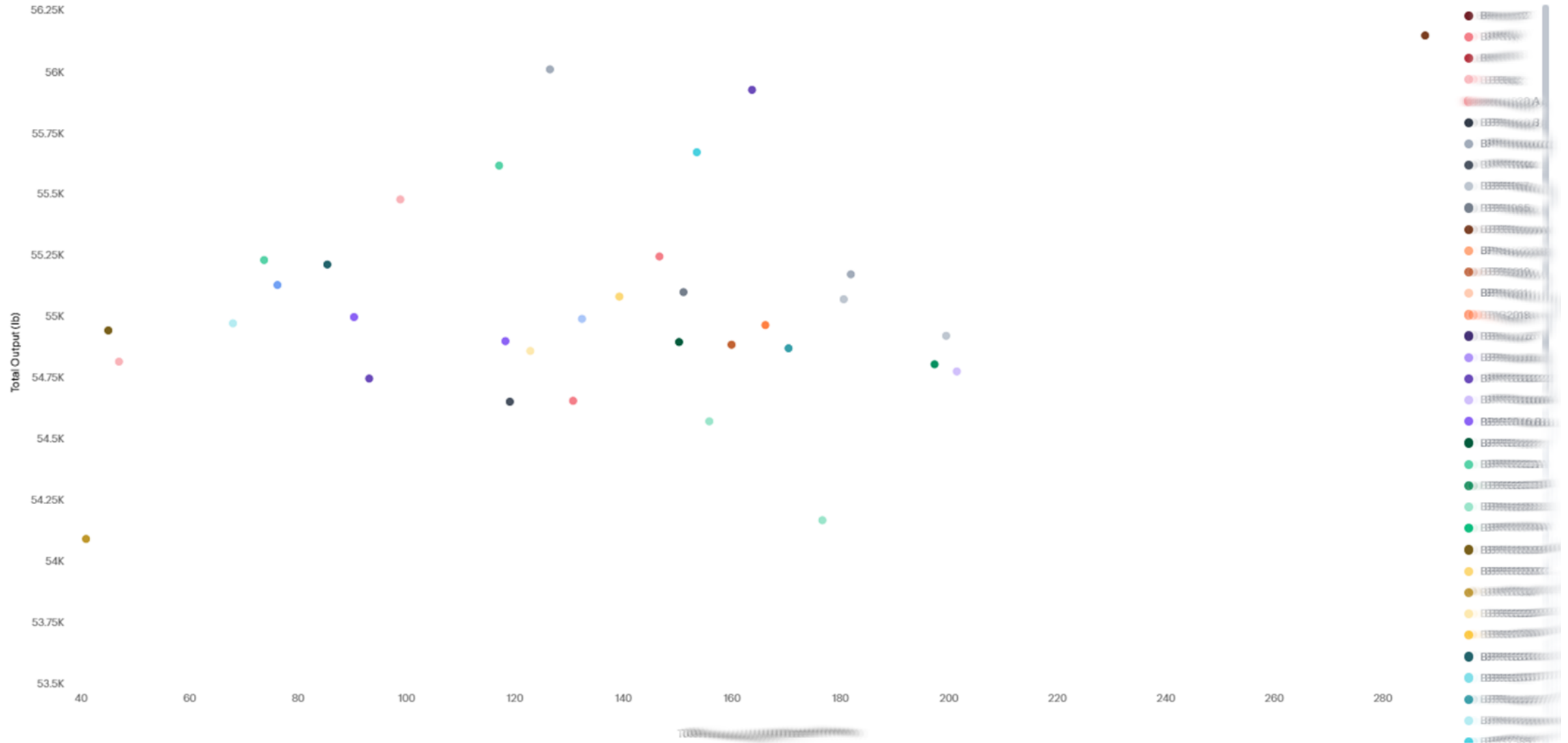


wash dura

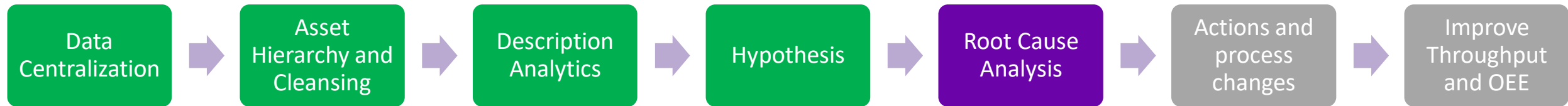
batch id

output (lb)

Total Output (lb) by Total (min) and Batch ID



Our Journey





Takeaways

- Fit-for-Purpose analytics - Engineered vis-à-vis AI/ML
- Ratio : Count of Engineered analytics to AI/ML analytics
- PI Dev Club FAQ (PI sandbox environment)

Other Resources

[lessons-of-simplicity-in-iiot-analytics-for-operations-and-maintenance-om](#) (blog – 10-minute read)

[Analytics for industrial sensor data in the PI System](#) (3-part series, recording and slides)

[Layered approach to maintenance/reliability](#) (blog + workshop intro)

[Industrial IoT time-series data engineering - a layered approach to data quality](#) (blog + workshop intro + recording)

[PI System 101](#) (webinar recording – 1 hour)

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