Tech-Clarity

# Operations Data Management

*Five Facets to Gain Batch Process Insights*

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# Executive Overview

Urgency has never been greater for makers of biopharmaceuticals and consumer products to be faster, more efficient, and more confident in serving customers. As experts retire and regulators increase pressure, this need grows. Companies are look to Industry 4.0 technologies for digitalization and ideally predictive approaches to improve performance. At the heart of whether they succeed is their ability to manage operations data effectively.

Many companies are experimenting with new technologies, particularly advanced analytics such as machine learning (ML), but most cannot build scalable and sustainable solutions. This raises a host of questions:

- Why are so many projects failing to meet expectations?
- How can we get past proofs of concept (PoCs) and move on to enterprise-wide digital transformation?
- Beyond failing fast, can we finally move on from those experiments and succeed?

Many projects fail because there are needs that are not obvious. Creating the industrial data foundation for artificial intelligence (AI), ML, or other new technologies is possible but has several stringent requirements. Batch process manufacturers lag some others for various sound reasons; these companies:

- Have a mix of digital and non-digital assets
- Operations data vary in provenance and usage
- Have to satisfy a wide variety of stakeholders by discipline and level in the organization
- Have many types, formats, cadences, and volumes of data to bring together: from operational technology (OT), IT, and business partners such as suppliers
- Need to contextualize a set of varied data streams differently for various stakeholders, such as asset, product, process, or time
- There are thousands of use cases and applications to satisfy, and even in a moderate-sized organization, many of these situations arise unexpectedly

Data management has five main facets: collection and extraction, harmonization and storage; contextualization; analytics; and applications. Because of the complexities, nearly every batch manufacturing company is missing some elements of some of these facets today. They cannot succeed without a reasonably complete set of them.

Fortunately, there are solution providers with a broad footprint today. Many use an array of modern technologies that can interoperate with most IT and OT environments. A few data management platforms have grown up in the batch process industries and focus on enabling all five facets for their customers. Finally, we can begin to tackle these issues with some commercial support.

# Taking Action to Get Value from a Flood of Data

According to the US NSA and NIST, "The manufacturing sector generates more measured, observational, operational, modeled and experience-based data than any other sector of the economy, even surpassing the financial sector"[1] Pressure to compete typically leads manufacturers to a vision of digital transformation or Industry 4.0. The COVID-19 pandemic showed just how valuable it is to make changes rapidly, safely, and confidently.

## Value Drivers in Improvements

Today, companies seek to reduce variability with optimization, improve quality, boost yield, lower cycle time, improve reliability, and increase agility. Digital transformation is when all of the above data types are together, available as federated data for analysis in the correct context. This, in turn, can deliver insights for confident action.

Digital transformation is a means to understand root causes and make process improvements easier. The value is not in data management itself but in the business and process improvements it enables.

## Insights through Analytics

So how can a company gain insights and take action to improve? Artificial intelligence (AI) and machine learning (ML) are hot topics because they can provide insights that allow operations to see and take profitable actions. AI

However, less than half of those using report gaining significant enterprise value (less than 5% of EBIT).[3] Just having the AI – or even having all the data – is insufficient to achieve business value.

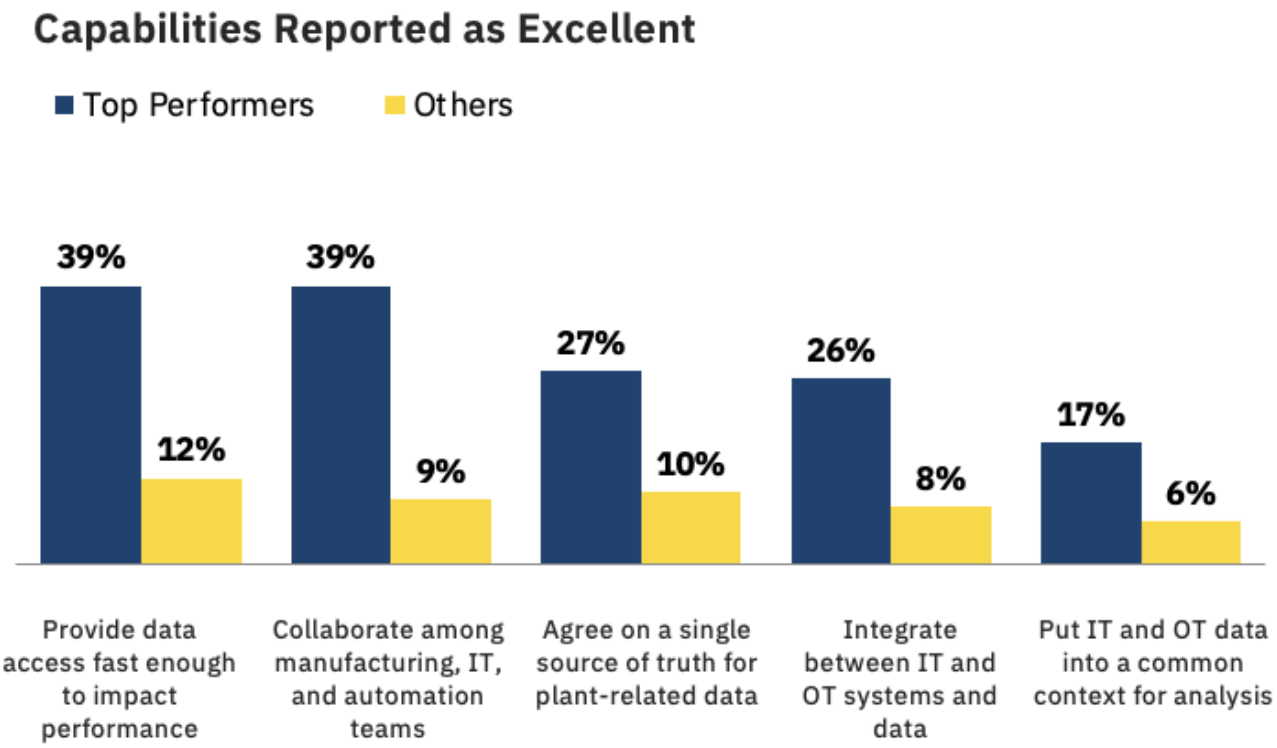
A company must apply analytics appropriately to in-context data in the proper workflow to deliver insights. And that's the end game. But not everyone is using AI; many are not ready yet.

## Basic Operations Data

Operations data management is a foundation to start moving toward analytics and Industry 4.0. And today, most manufacturers do not have the fundamentals of making data valuable in their operation. Our research shows that fewer than four of five professionals in top-performing manufacturers report that their organization excels at rapid data access for operations to take action that can improve performance or enable collaboration among manufacturing, IT, and automation or OT teams. [4]

A minority of even Top Performers (about 25% of the total) excel at empowering their operations teams with data in any dimension. Only about one in four are excellent at pulling IT and OT data together. Fewer than one in five can put IT and OT data into a shared context for analysis (Figure 1). The numbers are much lower for the other 75% of responding manufacturers.

**FIGURE 1: MANUFACTURERS CAPABILITIES ON MAIN ASPECTS OF OPERATIONS DATA MANAGEMENT**




## Disciplines: IT vs. OT

There is a challenge in merging OT and IT data. That's because the disciplines of IT and OT are radically different (Figure 2). One-third of companies get conflicting data from IT and OT.[3] Yet, IT and OT must finally come together to create the tech stack and data flows for a federated operations data management system.

**FIGURE 2: COMPARING OPERATIONS AND INFORMATION TECHNOLOGY (OT AND IT)**

| | OT | IT |
|---|---|---|
| **Mission** | Keep production running at top efficiency and quality no matter what | Keep data flowing in predictable, standard ways |
| **Priorities** | Minimize downtime, maximize process performance, serve the plant's priorities | Lower cost and effort to deliver data and information throughout the enterprise |
| **Skills & Background** | Automation, Controls, Process Engineering | Databases, Networks, Computer Science |
| **Views of Other** | IT are lawyers: try to push enterprise standards for technology, security, upgrades, that do not work well in the plant | OT are cowboys: not willing to conform to standards, and act impulsively rather than in a studied way |
| **Level in ISA-95** | Levels 0, 1, and 2 | Levels 3, 4 |

# Building a Data Foundation

IT/OT data convergence is essential to build out operations data management. It must all come together as one federated system. As with building a processing facility, the infrastructure, and architecture matter to long-term performance and flexibility.

## Why Batch Process Industries Lag

Industrial settings lag business-to-consumer (B2C) industries in analytics and the required data management. Industries that have been using AI and ML for years with great success include social media, eCommerce buying sites like Amazon, and financial services companies. There are many reasons why batch process manufacturers have lagged (Figure 3).

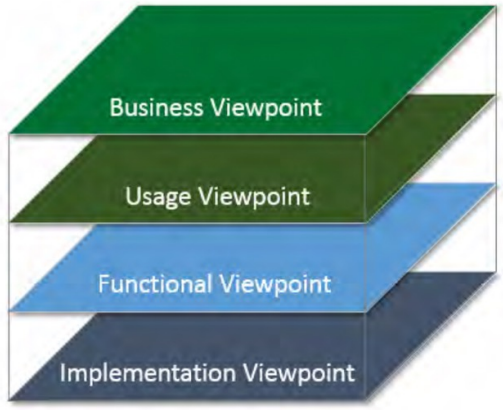
> “Right now, it’s a bit like the early days of the automotive industry, with lots of experimentation. For cars, it was differences from one brand to the next; it was unclear how you started the car or what shape the steering mechanism would take. Operations data management is like that now – there are many options, and it’s not clear which will last.
>
> — **Dennis Brandl**
> Founder
> **BR&L Consulting**

**FIGURE 3: BATCH PROCESSES CHARACTERISTICS THAT CHALLENGE OPERATIONS DATA MANAGEMENT**

## Levels and Viewpoints

A modern architecture will include many levels: Edge, Fog, Plant, Enterprise. This hybrid of on-premise and cloud-based data is emerging to be common. It helps to serve the various groups or viewpoints per IIRA[4]: implementation, functional, usage, and business (Figure 4). Each of these viewpoints is required for building the system so that multiple stakeholders can use the industrial data effectively

**FIGURE 4: INDUSTRIAL INTERNET REFERENCE ARCHITECTURE'S FOUR VIEWPOINTS**




## Five Facets of Data Management

Whether industrial or not, there are five main facets of data management (Figure 5).

1. Data collection/extraction
2. Data harmonization and storage
3. Contextualization
4. Analytics
5. Applications & Views

Each facet could be a very complex system unto itself, but they must work together as facets of a single industrial data management system. The following sections explain the specific industrial operations needs for each of these five facets of data management.

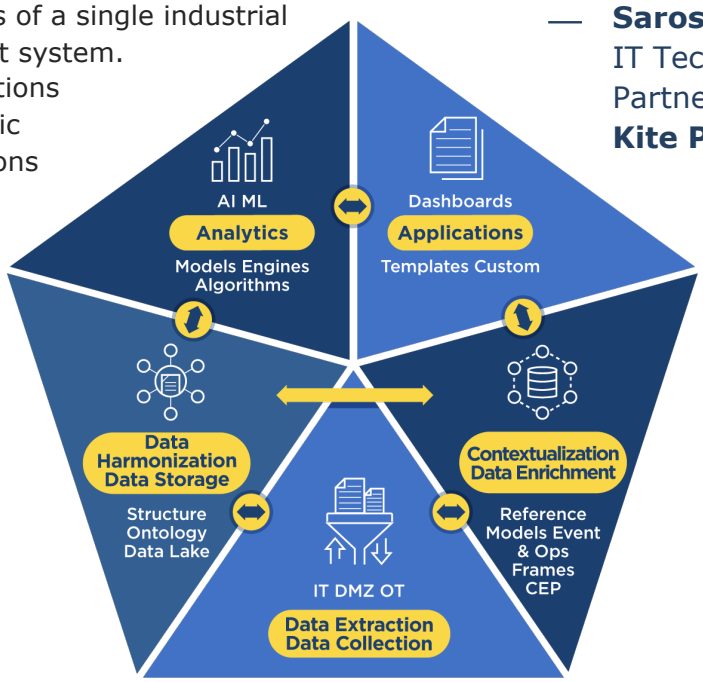



**FIGURE 5: THE FIVE FACETS OF OPERATIONS DATA MANAGEMENT**

> "ISA95 defines operations data management from planning to detailed execution with various levels of aggregation. For example, you might want to monitor very granular data from one sensor online to detect an issue. You might want to aggregate the data and put it into a batch record in MES for quality purposes. You may want to roll it up even further to just get a yield number out of a batch for ERP. Use cases take you to various levels of granularity.
>
> — **Sarosh Guzder**
> IT Tech Ops, Business Partner for PD and F&E
> **Kite Pharma**

# Facet 1: Data Collection and Extraction

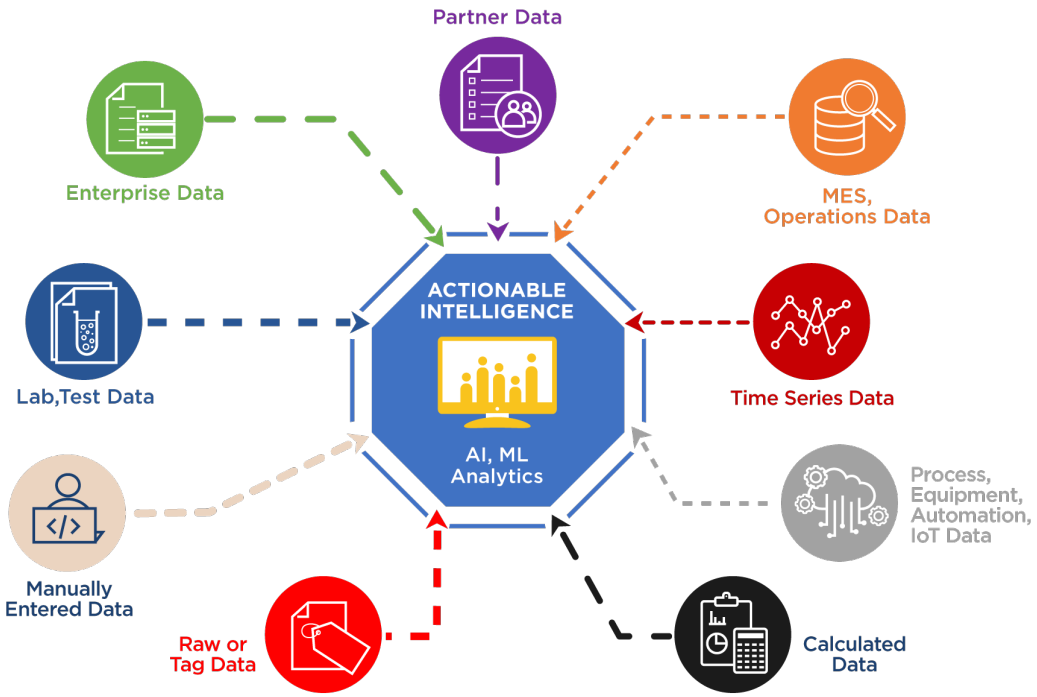
To manage data, you must get it from where it originates into a shared system. This facet may sound old—fashioned or straightforward but is pretty complex. In the industrial world, there is so much volume and so many types of data that most IT professionals from other industries would be surprised and dismayed.

## Collecting and Extracting Varied Data

Timely and complete information flows are a foundation for agility and continuous improvement (CI). In batch process manufacturing, it's particularly challenging because many crucial operational data streams from both OT and IT must come together. These varied data streams include not only database-structured data from enterprise and plant IT systems but also time-series data from historians, tag data from equipment, various formats from controls, sensors, and IoT devices. Some data is raw; some is calculated or aggregated around a process, batch, order, material, or product. Most plants also have data entered manually and then extracted into a spreadsheet, form, or database (Figure 6).

Typically there are several instances of each type of data flow to be collected, extracted, and federated (or even thousands). This is all the foundation for storing what is important and putting it into context for analysis and use in applications. With the vision of Industry 4.0, many are seeking to add new data streams.

**FIGURE 6: BATCH PROCESS MANUFACTURERS HAVE A WIDE ARRAY OF INCOMPATIBLE DATA THAT COULD ALL FEED ADVANCED ANALYTICS**



## Myriad Interfaces

The variety of data itself is just one aspect that makes operations data extraction complex. The interfaces just on the OT side are myriad – to name a few:

- MQTT for IoT
- OPC (UA, DA, Classic)
- Fieldbuses (the standard Fieldbus plus vendor-specific Modbus, Profibus, DeviceNet, PLCbus, etc.)
- BACnet for building automation

Time-series data from historians has unique characteristics and interfaces, also. And then, there are other more enterprise-style IT interfaces, including REST, SQL, CSV, ODBC, and other APIs. There are no less than 59 standards for data formats in the product, production process, and supply chain lifecycles for process industries.[5]

**Key questions to ask:**

- Do we have the means to collect or extract all the data we need now and in the future for complete data feeds to gain fundamental insights?
- Are our current mechanisms effective and secure?
- How much effort will it be the way we are doing it now?

## External Data Sources

In addition to equipment, plant, and enterprise data, manufacturers typically also need to incorporate data from outside. This ecosystem may include data streams from suppliers, customers, partners for contract manufacturing or specific processes, and regulators. Often, these make a difference in the settings and calibration needed for processing particular batches of products.

> "I don't think companies achieve value in a data lake project driven by IT alone, trying to capture all data in one place to provide visualization and analytics. I believe in a more distributed data model where IT and OT work together to provide a data hub approach. This allows for contextualization, analytics and visualization for the right audiences closer to real time. These hubs should integrate into the enterprise to provide overall visualization of the business as a whole. The key is to start bringing operational awareness back down into all parts of the organization.
>
> — **Gus Green,** Associate Director, Operations Technology, **Kriya Therapeutics**

# Facet 2: Data Harmonization and Storage

Many companies are focused on creating data lakes for storage; they are crucial, but need more structure to serve industrial needs well. Because data is not necessarily consistent, issues tend to arise when harmonizing data for effective storage and retrieval. Some expected differences include:

- Terminology per system, partner, or discipline
- Units of measure and whether they are clearly defined in the data
- Materials identification, particularly across suppliers and processes

## Many Contributors to Harmonize

Every data contributor must eventually be part of the harmonization effort. This includes various disciplines (production, quality, maintenance, scheduling, materials, etc.), labs, suppliers, partners, and sometimes distributors or customers. This need not happen immediately, and standards are growing up in some industries to address this. Meanwhile, data harmonization is large amount of work. Few have a complete ontology or overarching structure that shows how the properties of a subject area are related by defining a set of concepts and categories for each subject.

## Data Structure

A complete ontology may require quite a bit of structure. For decades, companies have created standard naming and terminology for particular sets of data. For federated data, that's probably not quite enough.

Namespaces are crucial to this since so many different types of data or objects need to be stored safely with easy identification. In IT, an ontology is often represented by a unified namespace. There might be 100 or 1000s of namespaces in an industrial data management environment, and the structure must accommodate them all to identify each object, data source, or data stream. ISA95 is typically a sound starting point for this harmonization to allow stored federated data to be more useful.

### Namespaces and Unified Namespaces

In IT, a namespace is typically a hierarchy of identifiers or *names* that refer to objects of various kinds. The purpose of a namespace is to ensures that all of a given set of objects have unique names. A unified namespace is a hub-and-spoke approach to data management that could be used across both IT and OT assets, often matching the ISA95 levels, constructs, and data flows. This can eliminate complex drivers and connectors to equipment and automation as well as to databases and applications.

## Storage Strategy

Industrial data can multiply exponentially – so storage needs strategy, not just space. As with all data storage, cloud storage is logical but can become very expensive. That may still be appropriate if it is primarily for off-line analytic use and aggerated. But not every bit of data from every tag and source may need to go into the data store. Companies need to ensure that data is stored intelligently, but that's not always obvious.

Today, plant data typically ends up in an array of data historians, MES, LIMS, QMS. This and OT data are typically stored on-premises; it's important to aggregate and harmonize it.

## Processes Matter

It is not likely that a company can harmonize data if they don't harmonize data naming, generation, and storage processes. Master data management (MDM) is one solution to reconcile data. And there are layers of processes to harmonize.

- Ensuring consistent processes throughout the plant operation
- Across multiple plants, whether they are feeder plants or sister plants
- Between production and the R&D and processes development groups

> "IT and OT each understand their layer. But the use cases are across those layers, and it takes time to adopt a methodology that works for everyone. Especially if you are aiming to allow people who run the process to create and use data effectively rather than having large IT and OT departments doing all of this.
>
> — **Sarosh Guzder,** IT Tech Ops Business Partner for PD and F&E, **Kite Pharma**

**Key questions to ask:**

- Is our data clean and consistent?
- Have we created standards for structure?
- Are we ready to work towards and ontology?
- Do we have or can we afford the storage space we need now and in the future?
- Do we have all the namespaces we need and the skill sets to set up all we'll need?

## Reference Architectures

Many models or reference architectures deliver sound guidance for industrial companies:

- Industrial Internet Consortium's (IIC) Industrial Internet Reference Architecture (IIRA) is strong and modern.
- The German Electrical and Electronic Manufacturers' Association's (ZVEI) Reference Architecture Model for Industry 4.0 (RAMI 4.0) shows layers with lifecycle and hierarchy dimensions for a structured approach
- US Smart Manufacturing Institute's (CESMII) smart manufacturing innovation platform is an example of our interoperability solution to deliver Industrial Plug and Play to all of industry.
- ISA-95 for controls-to-enterprise data flows
- ISA-88 for batch recipe structures and management
- Other standard bodies, associations, and public-private consortia worldwide have different models.

These models can help to ensure that you think through everything necessary for a particular aspect of operations data management. Yet, not set of reference architectures can provide the proper implementation of an industrial data management environment.

> "Traditionally, with a batch process, you're just seeing your batch data. It's hard enough to build that out and have proper recipe management per a standard. Then the issue is how to correlate other event data to your batch. I don't think many people are doing that, except maybe manually through deviation processes. We should be able to do that in a more automated fashion.
>
> — **Gus Green,** Associate Director, Operations Technology
> **Kriya Therapeutics**

> "IT builds out the cloud data lake infrastructure and then wants to put all data into the data lake. But often, the data model does not fit the OT or manufacturing use case. It's almost like an orchestra, figuring out how to coordinate all of this between the various layers of OT and IT. Yet, the difficulty is getting and keeping the pieces working together to achieve something combined.
>
> — **Sarosh Guzder,** IT Tech Ops Business Partner for PD and F&E, **Kite Pharma**

# Facet 3: Contextualization

Putting all of this data in context, so it becomes information is probably the most significant challenge for industrial data management. The Oxford Dictionary defines context as: "the circumstances that form the setting for an event, statement, or idea, and in terms of which it can be fully understood and assessed." We've already established that there are lots of data, but what is it that the data is trying to tell us? We only know based on how complete the context is.

## Layers of Context

Per the ISA88 Standard, there are layers of recipes and procedures. These physical layers are control, equipment, unit, process, area, site, and enterprise. Recipes ca be general, site, batch, or control. ISA95, on the other hand, looks at levels from the process (0) to sensing (1) to monitoring and control (2) to manufacturing operations management (3) to business or enterprise (4). This facet of operations data context must take all of those into account and much more.

## Context Per Discipline

Industrial data context has many aspects, each reflecting a different discipline. ISA88 reflects the batch recipe management process and considers the specific assets involved at various levels. Yet there is more to even those areas, and every discipline will need specific contextualization of data to perform their jobs well (Figure 7).

**FIGURE 7: DISCIPLINES (SHOWN IN THE FOUR CORNERS) AND THE DATA CONTEXTS THEY USE REGULARLY**

## Generating Context

Each system might have context, but only for its own scope. For example, per the ISA95 model, the MES layer (Level 3) typically has some responsibility for generating context for production data. Good MES can cover the process of a product through the plant to monitor and guide production.

Yet most MES cannot handle the full scope of industrial data – all of the OT data, from each piece of equipment, plus issues that are not directly about guiding the process, such as facilities conditions.

As a result of all of these layers and types of context, most processing companies will need complex event processing (CEP) to extract meaning from real-time production data. This enables analyzing multiple streams of information based on events to determine what might be a positive or negative event as it happens.

> "You need to understand what's important to your business to define context. What your business unit cares about is what you want to define context around. Then you need to focus attention on anomalies. If something went wrong, we certainly want to know. If it all runs well in a batch, we can release by exception: let it be passed and dispositioned out to a patient.
>
> — **Gus Green,** Associate Director, Operations Technology, **Kriya Therapeutics**

**Key questions to ask:**

- How much context do we have for our industrial data?
- How much do we have of each aspect?
- Do we have the skill sets to ensure we build out all aspects of context and keep them current as operations, equipment, and technologies change?
- Who is best positioned to create this context? IT or OT?
- How can we bring the domain expertise to bear on this?

# Facet 4: Analytics

Many companies are striving to get to advanced analytics for broader, deeper, more actionable insights than they've had to date. As always, getting AI and ML foundations in place and operationalizing their use involves people, technology, and processes.

**Skills:** Effective AI and ML typically need data science combined with domain expertise to succeed, and few manufacturers have that combination. Even if you have data scientists, most companies want to augment the use of their data and analytics to subject matter experts (SMEs) as well.

**Tools:** There are toolsets for data cleaning pre- and post-processing in addition to algorithms. Production has its own logic, and generic data science and AI/ML algorithms are often insufficient for this environment. To devise the right approach, you need process knowledge and data science. Most AI and ML tools are not designed to allow operations users to craft the analytics they need for insight and improvement, or even to work with data scientists effectively.

> "I've been part of OT-related ML pilots in which we identified additional data and context needed but not available in the target source systems. Then, we need to manually collect and contextualize that data. We try to automate as much as we can – pull data from EBR and other places to do this analysis. But humans are really good at applying context. The manual step does not allow the pilot to scale.
>
> — **Sarosh Guzder,** IT Tech Ops Business Partner for PD and F&E, **Kite Pharma**

**Data processes:** The amount of clean, in-context data most AI and ML approaches need is daunting. Many companies will need to revisit the data pipeline design or model if the signal is not in the data feed that results from using those tools. That means managing, monitoring, and refining models, so they remain relevant and valuable.

**New data methods:** Data governance, orderliness, and data framing to feed streaming machine learning algorithms are unique and require deterministic data pipelines. Turning a data scientist's ideas into production-quality code is crucial to success

**Operations:** Integrating AI and ML into daily operations may demand changes in work processes in IT and on the plant floor. Companies often need to make changes in equipment, integrations, processes, procedures, and mindsets to gain the full benefits of their AI and ML insights.

**Key questions to ask:**

- Have our advanced analytics projects paid off?
- Are the analytics tools we use integrated and well-suited to the problems we face?
- Do we have the skills, knowledge, and infrastructure to gain the insights we need today and in the future?
- What will we need to change to get to both daily and enterprise scale use of analytics?

# Facet 5: Applications

Any data management foundation delivers business value through applications that people use in production operations. So it's important not to stop at analytics but to understand the user-facing applications also.

Analytics and intelligence-based applications typically focus on critical KPIs. They may take the form of dashboards, live reporting displays, or alerts and trends. Common areas for analytics applications span the enterprise and its disciplines (Figure 8).

**FIGURE 8: COMMON AREAS FOR ANALYTICS-DRIVEN PERFORMANCE REPORTING**

## Make vs. Buy

As with other applications, intelligence applications can be purchased. Unfortunately, with the many differences in production operations, these often don't fit right out of the box (OOB). Canned approaches can even lead to compromises that limit the applications' ability to optimize performance.

Do-it-Yourself (DIY) has its downsides also. Standing up the other four facets and keeping them running is a significant challenge. Even if successful, the applications have all the same challenges for each one. Getting an application to validation, then to improvements, and finally to ongoing optimization and model re-training over time is difficult in DIY.

- if you have to amend the underlying templates
- building the data foundations in the other facets
- monitoring performance and re-training models as needed

In short, it's best to find a middle path with configurable or template-style applications that will mold to your needs and process preferences. Having a starting point can be highly valuable, but every company must expect to shape any analytics application to be exactly as you need it.

**Key questions to ask:**

- How much time and energy are we spending to get value from our data and analysis?
- Do we want to eb in the business of developing custom software from scratch, or do we want to start from a foundation that understands our style of business?
- Will the backlog become too great to develop from scratch and then maintain it?

# Consider a Complete Platform

Unfortunately, crafting an operations data management approach is somewhat of an all-or-nothing proposition. All levels and all five facets are crucial – miss one element of one facet at one level, and you won't be abl to scale to support your enterprise needs.

Now, that's not to say you can't start and gain incremental benefits along the way. You can. It's vital that you have the entire picture in mind, which is where a platform can be helpful.

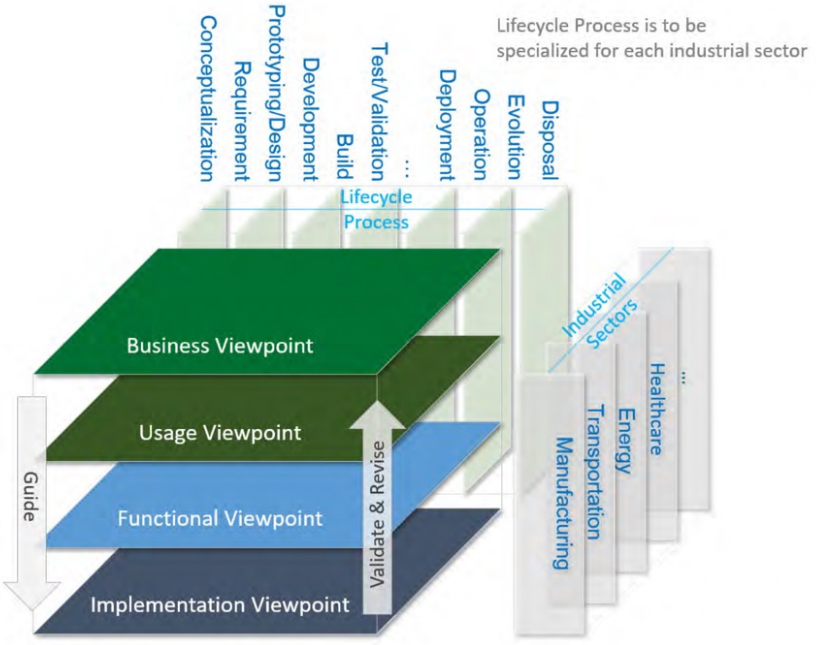
## Every Facet

Each of the five facets is multi-disciplined, complex, and potentially costly. Each requires security, the abilit to contribute to the federated model, and ideally feeds a digital twin of the operation.

Missing any facet or level, you can't gain the full benefit of Industry 4.0. Thus, we recommend considering buying as much of the stack and the five facets as an integrated system as possible. This can minimize your time, effort, and frustration build and integrate your operations data management infrastructure.

Building such an industrial data management foundation is a big undertaking that few production companies have succeeded in developing to date. Using the IIRA can be helpful; it shows how viewpoints or levels, lifecycles stages, and application scope intersect[6] (Figure 9).

**FIGURE 9: IIC'S IIRA SHOWING VIEWPOINTS, DATA LIFECYCLE, AND INDUSTRIAL SECTORS**




## User View

Even once it's built, it remains the underground majority of the iceberg – influential but invisible and often not respected for all it entails. Many IT infrastructure teams can attest that it's often better for someone else to maintain and improve the data infrastructure. Maintaining it and keeping up with emerging technologies as well as industry trends, needs, regulations, and operations changes is a long-term challenge.

Accessibility and security must not fight in the users' eyes. The operations data management system must be ready to deliver, securely yet with minimal friction, only what each user or group needs. Most companies don't have that in their systems today.

## Platform Approach

An operations data management platform is a middle path between do-it-yourself (DIY) and commercial out-of-the-box (OOB). Seek out a platform that blends configurability and tailoring to the environment with built-in capabilities that are continually updated and enhanced.

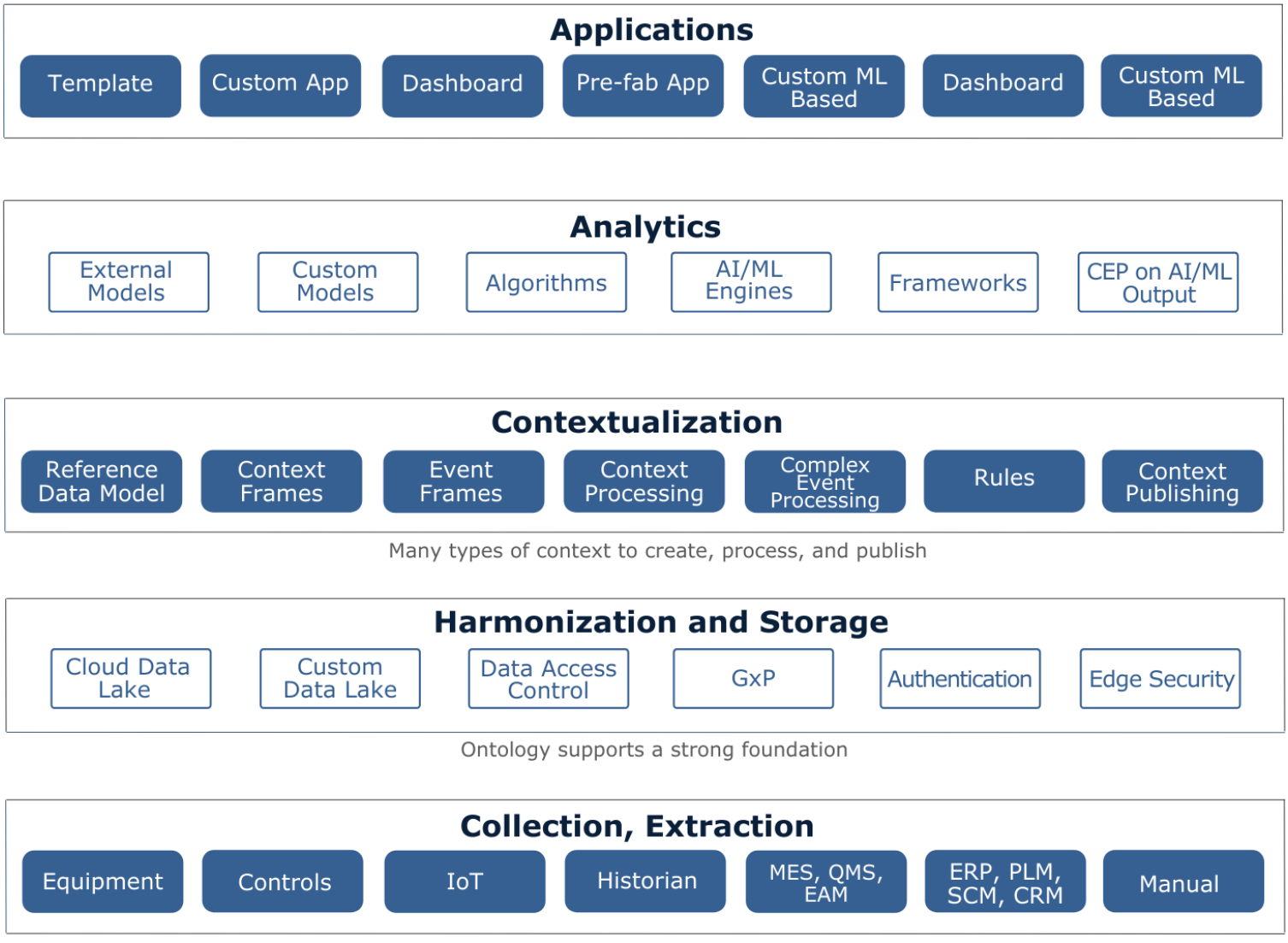
Remember, your goal is to get to business value – not infrastructure. So explore ways to get to the value you need. That will most likely require a platform that has batch process and regulated industry requirements baked into it from conception. The combination of technical and industry expertise from the platform supplier could spell the difference between data management foundation success and failure.

### Questions for solution providers:

- What is their experience and knowledge of your industry?
- Which reference architectures do they use and reflect?
- How strong are their data management credentials?
- Will they be able to leverage and work with the solutions you've already got in place and the company IT and OT standards you've set?
- Based on where you are in your journey, what are the starting points they'd recommend?
- Is their approach suited to your stage of maturity?
- How long will it take to get started?
- How much consulting time and fee do they predict you'll need?

> "Our enterprise architecture (EA) initiative is at the right time now. We have some systems to provide pillars to start with, but before we get too far and adopt random technologies, the EA will help us be purposeful in what we deploy. Without it, we'd waste time and money on things that don't integrate well. And that is costly – to the business, to the investors, and to the patients.
>
> — **Gus Green,** Associate Director, Operations Technology, **Kriya Therapeutics**

**FIGURE 10: THE FIVE FACETS OF OPERATIONS DATA MANAGEMENT SHOWN AS LAYERS WITH SOME ELEMENTS IN EACH FACET**



# Recommendations

Based on industry experience and research for this report, Tech-Clarity offers the following recommendations:

- **Focus on Value:** Set your sights on how to stay focused on optimizing our business, allowing solution providers to deliver the industrial data management platform.
- **Map It:** Operations data management is a journey each piece building on the next. It pays to map it out in advance and get prerequisites in place at each step.
- **Set Scope**: Set small goals and craft projects that deliver business value and some piece of the foundation simultaneously. More than a one-off PoC, but not "boiling the ocean," and always with a long-term view.
- **Commit Big:** Don't expect a silver bullet – this is hard work, just as ISA88 and 95 were; each facet is likely to be that much work
- **Communicate:** Educate everyone that getting to actionable insights requires all five facets of the data foundation to be robust and tightly integrated.
- **Multi-level:** Realize that this data foundation layer must include edge, fog, site, enterprise, and ecosystem layers.
- **Ask Hard Questions:** Don't assume anything internally or with solution providers. Many projects make significant gains just in mapping the current reality and spotting issues to address immediately, even without new technology.
- **Involve All:** Form a team for the initiative with all stakeholders – IT and OT, production, quality, maintenance, site-level, enterprise-level.
- **Partner:** Don't plan to do all the work yourself. You probably can't afford the time, money, and problems of DIY experimentation.
- **Test the Partner:** If an industrial data management platform provider seems like a good fit, craft a proof of concept (PoC) in the context of a larger long-term strategy.
- **Gain Benefits:** Rather than fail fast, seek to succeed relatively quickly in getting to the next step with industrial data management

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# About the Author

Julie Fraser is the Vice President of Research for Operations and Manufacturing for research firm Tech-Clarity. She covers Industry 4.0, Smart Manufacturing, MES/MOM, QMS, APS, APM/CMS, IIoT, AR/VR, other technologies and solutions for manufacturing.

Julie has over 35 years as an industry analyst in addition to experience in marketing and strategy (Berclain/Baan, now Infor) and editorial roles for computer and technology publications. She worked as an assembler over college summers and that got her hooked on manufacturing. She has a BA in German and French, Magna Cum Laude, Phi beta Kappa, from Lawrence University in Wisconsin. She is also a certified business change agent and conscious business ambassador.

Julie's current areas of research include the realities of moving Industry 4.0 from vision to reality; the role of MES/MOM in the new landscape; incremental vs. transformational change in manufacturing; approaches to empower plant workers and their leaders; IT/OT convergence; personalized and local manufacturing; and more. She is fascinated by the organizational, cultural and personal transformations required to drive success with new technology and approaches to manufacturing.

Julie is a certified yoga and meditation teacher. When she's in love with life, good things like the opportunity to work for Tech-Clarity come at the right time.

Julie can be reached at julie.fraser@tech-clarity.com. You can read additional research, watch Tech-Clarity TV, or join the Clarity on PLM blog at www.tech-clarity.com. You can also follow Julie on Twitter at @JulieFraser, or find Tech-Clarity on LinkedIn and Facebook as TechClarity.Inc.

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