BROCHURE

Digitalization for the chemical industry



Introduction

The fourth industrial revolution is underway toward more digitalized, data-driven operations. As companies around the world move into the next era of innovation, chemical plant operators recognize the need for changes in how they operate. In a recent Ernst & Young CEO Outlook Survey, 65% of chemical leaders said digitalization will significantly affect their businesses, making it one of their top capital priorities.

Recent years provide a 20/20 hindsight for future-forward strategies that not only formulate agile operations to help insulate the business from significant market variations in price and order volumes but also supply parameters to prevent operational compromises while maintaining a safe and productive environment for employees, regardless of their location.

By embracing a digitalized operating model, the flow of data around the organization is amplified yet secure and readily accessible with pivotal, reliable information. At the same time, decision-makers benefit from greater visibility into operations, allowing them to identify new opportunities for growth and efficiency. In addition, this model's trusted, accurate and timely data facilitates producing a more intelligence-enhanced approach to meaningful impacts across functional areas, including research and development, manufacturing supply chain, health and safety, operations and more.

Reshaping chemical operations

According to McKinsey, three major trends are reshaping chemical companies' operating models: rapid technological innovation, shifting customer expectations, and rising pressure on cost and productivity. Together, these forces are disrupting legacy work methods and underscoring the need for a full end-to-end (E2E) digital transformation.

Advancements in technology and innovation

Chemical operators are now hungry to invest in advanced technology to boost the development of new products and services and reignite post-pandemic economic recovery. For instance, deploying digital technologies that facilitate two-way communication, such as electronic shift logs and handovers, can help to reduce face-to-face meetings and informal discussions. Another sound investment for chemical facilities is remote access to plant information via cloud-based digital twin technology, which allows chemical producers to operate and maintain from anywhere and ensure the right tools are in place to withstand disruptions.

By using centralized databases and digitized records and processes, chemical companies save time, money and resources by capturing data and streamlining information, making it available for analysis and action in near real-time.



Changes in customer requirements

As executives invest in digital tools to build leaner, more agile organizations, they must also continually reassess evolving customer requirements. This ongoing analysis helps companies refine their target markets based on factors such as labor costs, automation, additive manufacturing, and customization needs. However, rapidly adjusting to these shifts is difficult without a fully digital end-to-end operating model.

Sustainability is also reshaping customer expectations and operations. According to EY (2022), four in ten chemical CEOs see digitalization as essential to meeting their sustainability goals. Growing regulatory and customer pressure is pushing facilities to adopt circular-economy practices that reduce environmental impact while maintaining efficiency. Like digital transformation, sustainability requires ongoing improvement, and integrating both into a unified strategy delivers stronger business results while supporting environmental commitments.

Mounting cost and productivity pressures

McKinsey notes that during periods of rapid growth, digitalized operations supported by analytics can increase yield and throughput while reducing costs, effectively unlocking additional capacity.

At the same time, a seamlessly integrated supply chain and commercial function ensure this new capacity is allocated to the most profitable customer and products, delivering the best possible margins.

Similarly, this same model can help proactively engage sales to “push” lower-margin volumes into the market to fill capacity and absorb fixed costs while tracking the reallocation of demand across plants and suggest the temporary shutdown of entire lines.

In addition, through enhanced digitalized awareness, management is awarded elevated insights to support efficiency and flexibility, which may include right-sizing and restructuring the allocation of resources across the company and even suggesting optimal timing for onboarding contractors during peak activity.

Digitalization is the key to resilience

Measures instituted today can be vital to navigating future market impacts and disruptions successfully. However, as operators implement mitigation methods, they should also consider the long-term effects of each change to seize opportunities that establish competitive advantages.

Now's the time for the chemical industry to adopt significant digital transformative technologies that can drive lasting resiliency, such as:

Situational awareness technologies
Integrate geospatial and time-series data, operators can manage Simultaneous Operations (SIMOPS) and assess incidents more effectively. They can monitor personnel throughout the facility, identify risks and opportunities remotely, and respond quickly. When combined with AI and facial-recognition tools, this technology can also control facility access and verify that workers are wearing required PPE.

Real-time reality capture
Give operators the ability to review and refine plant situations wherever they are and without waiting for manual, paper-based information through advanced sensors/laser scanners.

Digital twin modeling
Provide an accurate digital 3D model of the plant with information from across the asset lifecycle, including operations and maintenance. The digital twin also allows operators to demonstrate compliance with regulatory authorities, avoiding stringent penalties for breaching requirements.

Data digitalization
Eliminate the need to collect, store and sift through cumbersome and expensive hard copies. Once digitized, the field workforce can access that data using tablets and mobile computing devices to develop connected worker strategies.

Data centralization & aggregation
Unlock data from multiple enterprise systems (ERP, real-time, engineering, control of work) into a single pane of glass/dashboard to provide at-a-glance access to critical metrics, saving time and effort and reducing errors.

Enhanced parts management
Reduce capital in holdings through better administration and knowledge of equipment models/variants and parts.

Shift management solutions
Simplify and accelerate the shift hand-over process with intelligent event logging and improves communication between shifts without face-to-face meetings.

Regardless of the approach, digitalization efforts should be prioritized based on the size and value of the competitive advantage they can deliver. For example, production improvements require significant effort but can generate substantial gains. R&D investments in chemical process development demand far less effort yet still offer meaningful benefits. In contrast, enhancements in logistics, procurement, and general administrative functions typically require moderate effort but may yield smaller overall returns.

The Digital Maturity Model

Unlike the automotive industry, which harnesses technological advancements quickly and ahead of the adoption curve, according to DECHEMA, the German association of chemistry professionals, large chemical companies are now racing to embrace a digitalized operating model.

Through digital transformation, opportunities arise that increase operational efficiency and apply data to the challenges of designing new products and processes. Using smart sensors, machine learning and artificial intelligence, chemical producers can increase data availability, processing, and engineering and materials research capabilities.

However, these advancements are contingent upon developing a Digital Maturity Model (DMM). An effective DMM presses the business forward using digitalization to drive better investment decisions so that leadership retains focus on high impact initiatives that propel growth. Given the current economic climate, a DMM's value is even more apparent.

DMM is not an "IT issue" despite the 'digital' reference. Instead, businesses must adopt an organization-wide strategy that sees data being used and applied to all business sectors at every level. Digital transformation aligns culture, people, processes and tasks to focus on strategic outcomes. This may also require forming strategic partnerships to obtain additional digital skills and resources or to outsource secondary responsibilities, allowing operators to focus on production.

The role of the digital twin

In manufacturing industries, DMM is often closely related to the concept of the digital twin – an electronic model that renders a 3D model of the plant's distillation column. Gartner defines a digital twin as "a software design pattern representing a physical object to aid in understanding the asset's state, responding to changes, improving business operations and adding value."

Although a digital twin is crucial to connecting enterprise applications to create a single version of the truth, building an effective digital twin is a multi-stage process, just like any other data-centric digital transformation effort.

Stage 1 – Structured documents

The first stage of building a digital twin starts with a basic set of structured data and documents that define the facility configuration, designed by engineering teams in the project twin. This is an excellent start for companies near the beginning of their digital transformation roadmap, empowering better decision-making from more intelligent data and improving engineering-to-operations handover processes.

Stage 2 – Going graphical

The second stage connects intelligent data to 2D schematics, 3D models or laser scans. This allows for a more intuitive viewing of data and navigation and unlocks the benefits of linking engineering, operations and maintenance information in an operational twin.

Stage 3 – Linking to operations

In the third stage, the operational twin gains greater interoperability by exchanging data and linking to other systems across the operations landscape. This allows asset performance tools, data historians, maintenance management systems, and real-time data solutions to be integrated into the digital twin.

Computerized modeling then gives engineers a full view of the column's production, yield, operations, and maintenance data, and enables them to test enhancements or process changes without disrupting production or causing downtime.

Stage 4 – Value-added processes

The fourth stage is where the major business benefits of digital transformation emerge. Asset owners and operators can use the digital twin to manage value-added work processes such as human procedures, inspections, safe-work systems, and change management. This stage also incorporates advanced analytics, AI, machine learning, and predictive or prescriptive insights to minimize downtime. As the digital twin expands, its data must be efficiently analyzed and converted into actionable information.

Achieving excellence and growth in the chemical industry

Deloitte has identified three strategic pillars shaping the digital future of chemicals: growth and innovation, performance and cost optimization and sustainability.

Growth and innovation

Innovation is critical for exiting any economic downcycle and establishing a competitive advantage. Developments in digital technologies, like the Internet of Things, intelligent sensors, machine learning and artificial intelligence linked with low-cost data storage, can help drive robust development. In addition, increased computing power delivers the speed at which new chemical products can be discovered and commercialized faster.

Digitalization can be a real value-add for many chemical enterprises to enhance existing production lines. At the same time, leadership must evaluate a technology's disruptive potential. As noted by McKinsey, management must know what technologies can do and how to bend them to their strategic goals. Waiting for industry confidence in technologies to be fully baked before onboarding innovation to evaluate how they will work for or against them may be detrimental. Sometimes, a company must disrupt its business model before a rival or a new entrant does.

Performance and cost optimization

Content: Smart column facilities are essential for chemical manufacturers, helping automate processes and improving the flow of information between systems. As a result, they can dramatically improve their capabilities to improve energy efficiency and reduce byproduct wastage and heat and emissions.

The next step on the road to digital maturity is data integrated with physical assets to further enhance the performance of the smart facilities column. Intelligent use of the data generated by IoT sensors improves track-and-trace capabilities. As a result, operators can better fine-tune yield mid-production to respond to changes in demand or costs of raw materials, which automatically boosts process efficiencies.

Sustainability

Chemical producers—and industry as a whole—face growing pressure to support a greener global economy by investing in technologies that reduce carbon emissions and other environmental impacts. The International Monetary Fund (IMF) has even urged governments to make emission cuts a condition for state aid to industry.

While digitalization is often viewed as a technical undertaking, the right tools can also help plants achieve sustainability goals. Smart technologies can reduce supply chain waste and highlight improvement opportunities across the production cycle.

Digitalization alone won't solve every sustainability challenge, but with the right people, culture, and technology, chemists can drive meaningful progress. Advanced production systems can even calculate a product's environmental footprint before manufacturing begins.



Overcoming the barriers that delay digitalization

Digitalization provides a way for chemical manufacturers to establish a competitive advantage.Those who adopt early, particularly while the rest of the chemical industry lags behind, can realize the most significant benefits. Given the current economic situation, the chemical industry must act to remain competitive – and afloat. Although building smart process facilities columns, production lines, and transparent supply chains is relatively complex, the potential advantages are substantial. Those already engaged in digital transformation may encounter issues that hamper their efforts to achieve maturity. Acknowledging these barriers in advance offers an opportunity to plan a response. Here are three that every chemical operations manager should be aware of:

Barrier #1: Insufficient stakeholder buy-in

Because digital transformation affects every person at every level of the business, projects require buy-in and support from all stakeholders. Without a shared vision of data-driven operations, efforts will be unfocused, yielding less-than optimal outcomes.

Stakeholder buy-in is hard to secure precisely because of the lack of transparency in operations.

The irony is that digitalization can meet alldemands and more.

Digitally mature firms typically appoint a small team responsible for defining and implementing the transformation strategy. This group must be empowered to conduct experiments – and potentially make mistakes – in their ongoing efforts to identify and implement new ways to use data to create efficiencies. A digital twin will help to lessen the chances of production being affected by making more information available, allowing for more accurate strategic planning and decision-making.

The project team needs public support from senior management to drive the project through its various stages. The key is to begin the transformative process, growing and progressing as processes and people allow.

Barrier #2: Incorrect prioritization

Digital transformation rarely succeeds as a single "big bang" project. It is usually an ongoing process of continuous improvement, with iterative changes building toward a larger goal. A strong understanding of the digital twin's foundational role in enabling technologies like AI and machine learning is critical—advanced analytics applied to poor, inconsistent, or incomplete data is unlikely to deliver expected benefits.

Chemists are already familiar with iterative processes: production requires extensive testing and adjustment to achieve the right formulation. Applying the same mindset to technology and operations positions chemical producers to successfully embark on iterative digital transformation.

Strategic partners can provide valuable guidance by sharing insights from similar projects, helping define priorities, and ensuring non-essential tasks do not consume unnecessary time, money, or resources.

Barrier #3: Lack of communication

Constant flow of relevant information keeps employees engaged with the process, particularly if they can see that the transformations have a positive effect.

Communication will also be vital to keeping stakeholders informed of their responsibilities. Everyone has a role to play in collecting and sharing data, and they need frequent training and updates to ensure information is handled correctly and the correct KPI information is being recorded. By soliciting feedback from stakeholders, you can redefine KPIs as the project matures, which is critical to implementing a culture of continuous improvement that reduces costs and improves the overall quality of the chemical product.

Communication is not just an internal issue either. Partners need to be kept in close contact to play their part in pushing toward shared goals. Recognizing this, digitally mature companies often involve partners in strategy meetings, keeping them informed of progress and allowing them to provide insights that can enhance planning.

Digitalization is all about communication and providing easy access to trustworthy information. This may take the form of production manager reports or automated responses to sensor data on the distillation column. As the digitalization project progresses, systems must continue to prioritize communication and improve the efficiency and profitability of every production run.

In the tightly integrated supply chain era, communication must also improve with ingredients suppliers and retailers. The list of stakeholders will include third parties as digitalization efforts extend beyond the production line.



Take the next step to achieving digital maturity

Digital maturity is a worthy goal for any business in the chemical industry - and as more organizations adopt data-driven operations, it will become a strategic necessity. However, given that the chemicals sector has been relatively slow to embrace digital transformation, there is still plenty of opportunity for producers who act now.

There are technical, political and procedural challenges, but all should be manageable with the right partners and a system capable of creating a real-time digital twin. Indeed, the choice of partners will be crucial to transforming an embedded process of constant optimization.

The benefits of true transformation are substantial. Improved efficiency and market share enhance cost control and strengthen profit margins—even on typically low-return, high-risk production runs. When adopted quickly, these changes can help companies navigate a potential recession and return to profitable growth.

To learn more and explore how Octave can help your business achieve its strategic digital transformation goals, contact us today.

References

1. Digitalization is transforming the chemical industry - ey.com - Frank Jenner, EY Global Chemicals & Advanced Materials Industry Leader and Global Advanced Manufacturing & Mobility Supply Chain Leader
2. Disruptive technologies: Advances that will transform life, business and the global economy - www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/disruptive%20technologies/mgi_disruptive_technologies_executive_summary_may2013.pdf
3. Digitalisierung in der Chemieindustrie – DECHEMA - dechema.files.wordpress.com/2016/09/whitepaperdigitalisierung_final.pdf
4. Gartner Survey Reveals Digital Twins Are Entering Mainstream Use – Gartner - www.gartner.com/en/newsroom/ press-releases/2019-02-20-gartner-survey-reveals-digital-twins-areentering-mai
5. Achieving the next frontier of chemicals excellence – Deloitte - www2.deloitte.com/content/dam/Deloitte/us/ Documents/energy-resources/us-er-achieving-the-next-frontier-of-chemicals-excellence.pdf
6. Nations Must Promote 'Green Recovery' From Virus, IMF Chief Says – Bloomberg News - www.bloomberg.com/news/articles/2020-04-29/nations-must-promote-greenrecovery-from-virus-imf-chief-sa
7. End-to-end digital transformations for chemical companies - www.mckinsey.com/industries/chemicals/our-insights/end-to-end-digital-transformations-for-chemical-companies
8. Shaping digital sustainable development in chemical companies – Wolfram Keller and Nadine Bette, Journal of Business Chemistry - www.businesschemistry.org/downloads/articles/Issue02-2020_373.pdf

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