

Magic Quadrant for Manufacturing Execution Systems

Published 30 March 2021 - ID G00464732 - 70 min read

By Rick Franzosa, Christian Hestermann

Global MES solutions are a foundational building block of smart manufacturing strategies and digital business for manufacturers. Disruptive technologies and new providers are shaking things up. Supply chain technology leaders should use this research to select appropriate vendors and solutions.

Market Definition/Description

Gartner defines manufacturing execution systems (MES) as follows:

“MES is a specialist class of production-oriented software that manages, monitors and synchronizes the execution of real-time physical processes involved in transforming raw materials into intermediate and/or finished goods. These systems coordinate this execution of work orders with production scheduling and enterprise-level systems like ERP and product life cycle management (PLM). MES applications also provide feedback on process performance, and support component and material-level traceability, genealogy and integration with process history, where required.”

These capabilities extend the product/process design release (PLM) and work order release (ERP) through completion of the manufacturing process for both process and discrete industries. Gartner’s view of the MES market does not include production automation or operational technology (OT) software, such as supervisory control and data acquisition (SCADA), distributed control systems (DCSs) or programmable logic controllers (PLCs). It also does not currently include Industrial Internet of Things (IIoT) platforms, although these technologies have become increasingly important in the MES space (see [Magic Quadrant for Industrial IoT Platforms](#)).

Core MES Functionality

To qualify for inclusion in this Magic Quadrant, vendors must provide in their standard product all of the following nine core MES functions:

- **Dispatching:** The ability to dispatch work based on global instructions from ERP, adapted to meet resource availability, schedule requirements and capacity.
- **Production management, execution and in-process quality monitoring:** Managing the production process from order release to work in process (WIP) to finished goods.

- **Data collection:** To meet the requirements above, the MES must have the capability of collecting data manually from end users, at regular intervals from a data storage source (e.g., data historian), directly from equipment, or some combination thereof. This is data spanning domains of quality, process status, job/order status, regulatory compliance, labor collection and tracking/product genealogy, to name a few.
- **Operational data store:** An operational data store can be anything from a simple relational database for transaction-based operational data or integration capabilities to a data historian for time series and transactional data.
- **Manufacturing-related quality management processes:** For regulated environments, where corrective and preventive action (CAPA) and nonconformance workflows are required to be inextricably linked to the production process.
- **Procedural enforcement:** Ensuring that all manufacturing process steps are performed in the correct order, at the right time, by the correct resource and in conformance with quality requirements.
- **Tracking and genealogy:** The ability to track where each item is in the production process. And, as required per industry, the source and unique identification of the parts and materials that compose the item being tracked, as well as the equipment and personnel, in support of regulatory compliance, field service and product recall management.
- **Integrated reporting and plant key performance indicators (KPIs):** Tools and techniques for generating KPI results, performing advanced analytics and providing dashboard displays and datasets for performance monitoring and reporting.
- **Sophisticated integration capability:** Use of tools and APIs to integrate to:
 - Production equipment (process historians, robots, PLCs, SCADA systems, edge devices, data collection systems)
 - Enterprise systems (ERP, SCM for materials management, inventory, order status, completions)
 - Engineering/PLM (model-based planning, with automated routing, work instruction and related data flowing to the MES environment, bill of materials [BOM]/recipe management, and engineering change management)

Manufacturing Operations Management (MOM)

As the MES market has matured and expanded, additional capabilities have been added by MES vendors; these are typically referred to as manufacturing operations management (MOM) functions. This has led to some vendors referring to their solutions as MES/MOM, or simply MOM. The term “manufacturing operations management” is defined as Level 3 of the ANSI/ISA-95 Enterprise-Control System Integration standard. ¹

Extended MES/MOM functionality includes:

- **Resource management:** This can include management of all resources required for manufacture, including:
 - Equipment (computerized maintenance management systems [CMMSSs]/enterprise asset management [EAM])
 - Labor (labor management, certification/training management)
 - Materials (inventory management, warehouse management)
- **Manufacturing process management/model-based manufacturing:**
 - BOM/recipe management
 - Process planning/work instructions
 - Model-based manufacturing (for products and processes)
- **Analytics:**
 - A suite of development and runtime software tools that monitors, alerts and supports interactive decision making by providing data and analytics about current conditions
- **Quality management:**
 - Manages quality policies and standard operating procedures (SOPs). This may include, but is not limited to, customer requirements, quality documents, ISO requirements, manufacturing capabilities, robust design, auditing procedures and protocols, nonconformance/risk management activities, testing criteria, and industry-specific regulations (for example, U.S. Food and Drug Administration [FDA] or Federal Acquisition Regulation [FAR] requirements).
- **Planning/scheduling:**
 - Detailed production scheduling
 - Supply chain scheduling (e.g., suppliers, contract manufacturers, remanufacturers)

Note: The depth of functionality in these specific extended MES categories was not considered in the MES Magic Quadrant scoring. However, the general availability of offerings supporting these categories in both Completeness of Vision and Ability to Execute is factored into the scoring.

The next phase of the evolution of MES/MOM will be the convergence of technologies (processes) that support end-to-end supply chain planning and execution functions (see [Understand the Need for Supply Chain Execution and Manufacturing Operations Management Convergence](#)).

Magic Quadrant

Figure 1: Magic Quadrant for Manufacturing Execution Systems



Source: Gartner (March 2021)

Vendor Strengths and Cautions

ABB Ability

ABB Ability (ABB) is a Visionary in this Magic Quadrant. The ABB Ability Manufacturing Operations Management (MOM) suite is a comprehensive manufacturing operations and asset management suite. ABB's operations are geographically diversified, and more than two-thirds of its clients are manufacturers in the oil and gas, chemicals, paper, printing, minerals, and mining industries.

ABB released a Microsoft .NET Core and microservices architecture in 2019 and has launched the development of its next-generation product, Integrated Operations Management (IOM). IOM will be built on these platform services, with an automation enabler and MOM core pillars, supporting performance management and industry-specific application modules.

Strengths

- **Offering (product) strategy:** As part of the larger ABB Ability platform, ABB capabilities in robotics, logistics and analytics from device to cloud can be leveraged by customers. These capabilities are managed via platform security for data and intellectual property (IP) protection.
- **Customer experience:** Customer reviewers give ABB high marks for data security, product reliability and process manufacturing functionality. This is especially true for customers that leverage the entire set of ABB offerings.
- **Product or service:** The ABB Ability MOM solution is ERP-agnostic, and is also able to run in the absence of an ERP connection. It provides some ERP functionality such as order creation and materials management (master data and material substitution) and warehouse management system (WMS), in addition to MES capability if required.

Cautions

- **Product or service:** ABB's next-generation product (the IOM platform) is under development and represents an ambitious change in how ABB develops and delivers its applications. Given the effort to migrate complex environments, Gartner estimates that it will take two to three years until IOM will deliver value across ABB's existing customer base.
- **Customer experience:** Vendor briefings demonstrated a requirement for a significant amount of master data preparation compared with other vendors in this Magic Quadrant. Clients should be prepared for the effort needed to make the solution successful.
- **Operations:** Data conversion and import can be performed via data transfer techniques. However, the UI for managing this data is complex, not very intuitive and will require significant training and expertise to master.

AVEVA

AVEVA is a Leader in this Magic Quadrant. Its product that is reviewed in this research (AVEVA Manufacturing Execution System, formerly known as Wonderware MES) is mainly focused on process and batch manufacturing. Its operations are geographically diversified. More than two-thirds of its MES customers are in the process manufacturing industries.

AVEVA is investing in a suite of "model-driven MES" capabilities — from edge to enterprise. It has also been active in the market, extending its manufacturing operations capabilities via the acquisition of OSIsoft, as well as via partnerships with PlanetTogether, Poka, TwinThread and others.

Strengths

- **Market understanding:** AVEVA MES (previously known as Wonderware MES) has always been a device-agnostic open platform, which provides for flexibility in connecting the MES layer to automation equipment, regardless of vendor. This flexibility includes programming and commissioning of automation equipment, effectively creating a process digital twin.
- **Vertical/industry strategy:** AVEVA MES has a strong position in the food and beverage industry, and is also found in consumer products. These two industries account for nearly half of its customer base.
- **Innovation:** AVEVA, through acquisitions, partnerships and development, is advancing its manufacturing execution and analytics functionality. It is positioning itself well to take advantage of edge and IIoT capabilities now under development.

Cautions

- **Operations:** Customers and Gartner clients continue to report that time and effort for upgrades can be high, especially in multisite deployments, resulting in lower-than-average scores in this category.
- **Customer experience:** In some areas of the solution, the UI does not meet customers' expectations. Specifically, the need for custom development in dashboards and analytics was mentioned, as well as limitations in the quality management system UI.
- **Product or service:** As the AVEVA model-driven MES solution is made up of multiple components, customer references have voiced frustration because components are not yet fully integrated and have different roadmaps and release cycles.

Critical Manufacturing

Critical Manufacturing is a Leader in this Magic Quadrant. The Critical Manufacturing MES is focused mainly on discrete manufacturing. Critical Manufacturing's operations are geographically diverse across EMEA, North America and Asia/Pacific (APAC), and its clients tend to be in the semiconductor, electronics, repetitive flow/batch and medical device industries.

Critical Manufacturing has invested in SKT, a Shenzhen, China-based MES focused on surface-mount technology (SMT) to strengthen its coverage and presence in the China semiconductor market. Its product roadmap, leveraging its unique data management capabilities, continues its expansion into extended MES with features including quality (acceptable quality limits) and new product introduction (NPI).

Strengths

- **Innovation:** The Critical Manufacturing MES has strong data management, analytics and extended MES capability, supported by a sophisticated platform that manages both IoT and transactional MES data in the same data model.
- **Marketing execution:** As a smaller vendor, Critical Manufacturing leverages online customer-driven webinars, posts and blogs effectively. Examples include its 2020 HackaMES event,

which crowdsourced several innovative enhancements for its product line.

- **Customer experience:** Critical Manufacturing has enjoyed higher customer satisfaction scores than most vendors in this research.

Cautions

- **Geographic strategy:** Critical Manufacturing's geographic presence in North America is not as strong as in EMEA and APAC, likely limited by its comparably smaller size and limited partner network. Coverage in EMEA (its home territory) and APAC (the headquarters of its owner, ASM Pacific Technology) is not as affected.
- **Product or service:** Critical Manufacturing focused on automation later than other vendors in the space. It is advancing this capability, which is important for some of the industries served by this vendor (for example, semiconductors). Clients need to ensure that their integration needs can be met.
- **Operations:** This vendor's score for the deployment experience was markedly lower than its other scores and was below the average for the vendors in this research. Customers reviewing this vendor reported it is lacking in business process services and consulting expertise to leverage the solution. It has instituted a stringent partner certification process, which is valuable and necessary, but the ability to scale should be carefully assessed.

Dassault Systèmes

Dassault Systèmes (Dassault) is a Leader in this Magic Quadrant. Its MES offerings are DELMIA Apriso, which is focused at larger enterprises, and DELMIAWORKS, an ERP/MES combination focused at the small and midsize business (SMB) market. Both offerings are focused mainly on discrete and repetitive flow/batch manufacturing. Its operations are geographically diverse though the DELMIAWORKS product is found predominantly in North America. DELMIA Apriso is strongest in discrete manufacturing; DELMIAWORKS excels in repetitive flow and batch manufacturing.

Dassault continues to invest in DELMIAWORKS capabilities to support lean manufacturing discipline in DELMIA Apriso prepackaged roles/applications and in leveraging the 3DEXPERIENCE platform to enhance the DELMIA Apriso capability.

Strengths

- **Customer experience:** The Dassault DELMIA Apriso team focused much of its effort in the development of prepackaged roles and applications for its MES user experience (UX). The result is a compelling and user-friendly UI/UX. Currently available roles include Production Supervisor and Complex Assembly Production Operator.
- **Product or service:** The SHOPWORKS and RealTime Process Monitoring modules in DELMIAWORKS provide additional connected worker capabilities to SMB manufacturers and divisions of enterprise-scale manufacturers.

- **Marketing strategy:** Dassault Systèmes has judiciously leveraged acquisitions to provide global manufacturers with MOM capability, including supply chain planning and warehouse management, as well as engineering solutions (computer-aided design/computer-aided manufacturing [CAD/CAM] and PLM).

Cautions

- **Innovation:** The DELMIA Apriso product must continue to evolve its architecture to keep pace with the newest technology trends such as containerized microservices-based architectures. While it has a vision and a plan, with the exception of capabilities it inherits from the Dassault 3DEXPERIENCE platform, it has yet to demonstrate these newer capabilities.
- **Sales execution/pricing:** Dassault scored in the bottom third for sales execution. Gartner clients report that DELMIA Apriso's resource-based licensing model limits expansion and deployment in further facilities. There is evidence that some Gartner clients have chosen to pass on what they felt was a superior product specifically for this reason.
- **Geographic strategy:** The strategy shared with Gartner was that DELMIAWORKS would be increasingly sold and implemented by partners globally (as they are trained and certified for implementations). The company has reported 90% to 95% of implementations are currently performed by DELMIAWORKS' personnel, predominantly in North America, so Gartner sees DELMIAWORKS as having more work to do to fully support DELMIAWORKS customers globally through the partners strategy.

Emerson

Emerson is a Visionary in this Magic Quadrant. Its Syncade product is focused on life science process manufacturing, specifically pharmaceuticals and biotechnology. Its operations are mostly focused in North America and EMEA, and its clients cover a wide range of pharmaceutical capability – from traditional large pharmaceutical enterprises to small vaccine and cell and gene therapy (C>) providers.

Emerson has a very ambitious MES functionality roadmap, leveraging its successes in vaccine and C> MES and electronic batch record (EBR) functionality. Integration with the products from its 2019 acquisition of Bioproduction Group (Bio-G) continues, as it expands into the advanced therapy medicinal product segment.

Strengths

- **Business model:** Emerson has launched an innovative approach to customer-driven development using “play money” given to customers as a method of prioritizing product enhancements that is a much more customer-intimate approach.
- **Market responsiveness/record:** Emerson has had some impressive successes in the vaccine and C> arenas during COVID-19, with accelerated implementations and faster time to value.

- **Offering (product) strategy:** Emerson has effectively used partners to extend the reach and range of its solution (for example, Fluxa's Process & Knowledge Management [PKM] software).

Cautions

- **Product or service:** Although Syncade is compatible with multiple process control systems, the combination of Emerson's Syncade MES and its DeltaV Distributed Control System is its competitive advantage. Where process control systems are required, manufacturers will not get the same benefit without also deploying DeltaV. This was evident to Gartner in the system demonstration, which involved both Syncade and DeltaV.
- **Innovation:** Emerson continues to invest in Syncade; however, the roadmap shared with Gartner shows little in the way of architecture innovation. Gartner believes that this could hamper Emerson's customers long term in the ability to achieve composable MES. The roadmap consists of application functionality improvements.
- **Operations:** Emerson scores continue to lag behind most other vendors in this research in implementation and training support, as verified by customer reviews.

GE Digital

GE Digital (GED) is a Challenger in this Magic Quadrant. Its Proficy Plant Applications product is focused mainly on hybrid manufacturing and repetitive flow/batch manufacturing, but the functionality and clients are growing in discrete manufacturing. Its operations are geographically diversified as is its client base, although the client base is predominantly in the consumer products (consumer packaged goods [CPG]/food and beverage), chemical and automotive industries.

GE Digital's product strategy includes enterprise system management with zero-downtime upgrades, app store deployment, a common configuration hub and templates for easy repeatable configuration. It also includes continued differentiation of multimode MES and consistent persona-based UX for supported industry verticals.

Strengths

- **Innovation:** GE Digital was one of the first "old-line" MES/automation vendors to embrace new microservices/dockerized technologies to meld MES and IIoT capabilities. It released this capability in September 2019. Gartner believes this capability will be a real competitive advantage for GE Digital in 2021.
- **UX templates:** GE Digital is one of very few MES vendors to offer process manufacturing, batch/repetitive flow manufacturing, discrete manufacturing and mixed-mode manufacturing from a single application. This is backed by prepackaged UX templates supporting these manufacturing modes.
- **Customer experience:** GE Digital has made marked improvements in its Ability to Execute — most notably, in its customer experience scores.

Cautions

- **Product or service:** GE Digital scored in the bottom third of vendors in ease of upgrade as GE Digital migrates to a containerized environment. Gartner clients and customer reviews raise concerns about existing functionality not being carried forward to newer releases in a predictable way. The sentiment that we get from these clients is that, though GE Digital has kept to its product roadmap, strategic direction sometimes changes.
- **Operations:** GE Digital lags other vendors in this space with reported slower responses from product support. It is unclear if slow response was related to third-party support, GE Digital support, or both, but this was a commonly raised issue.
- **Offering/product strategy:** Early versions of the new HTML5-based UI do not contain all functionality that customers were dependent on in the traditional MES client, which created issues after upgrades.

Honeywell Forge

Honeywell Forge is a Leader in this Magic Quadrant. The Honeywell Forge product is focused on continuous process and batch manufacturing. Its operations are global, and its clients tend to be in the process industries (oil and gas, chemicals, mining and metals, and pulp and paper).

Since the previous Magic Quadrant release, Honeywell has embarked on rebranding and realignment of its manufacturing software under the banner of Honeywell Forge. Its go-to-market strategy is supported by partnerships with Princeps (advanced planning and scheduling [APS]) and Tech Mahindra (Industrie 4.0/smart plant), and the reentry into life sciences with the Aizon partnership and the acquisition of Sparta Systems that is expected to close at the end of the first quarter.

Strengths

- **Vertical/industry strategy:** More than 75% of the Honeywell Forge client base is in the oil/gas and chemical industries, supported by proprietary knowledge of manufacturing processes from Honeywell's own process technologies and manufacturing facilities.
- **Product or service:** Honeywell Forge has specialized in-house consulting and delivery capability for advanced analytics and specialized implementation for petrochemical industries.
- **Offering (product) strategy:** Honeywell Forge was rated highly in agility in custom development and the flexibility of the platform to adopt new requirements, intuitive UI, reporting and easy connection to DCSs.

Cautions

- **Customer experience:** Reference customers' reviews, together with other Gartner inquiries, reported performance and stability issues with the legacy Honeywell Connected Plant solution, reflected in lower-than-average scores in operations.

- **Operations:** The Honeywell Connected Plant MES (legacy) solution consists of eight modules. The rebranded and rearchitected Honeywell Forge suite reduces that number to four MES-related solutions, but the complete conversion is not expected to be completed until the end of 2021.
- **Market responsiveness/record:** Honeywell Forge specializes in oil and gas/specialty chemical industries. Manufacturing customers in pulp and paper have reported both a decline in support and increased service costs.

iBASEt

iBASEt is a Visionary in this Magic Quadrant. Its Solumina product is focused on complex discrete assembly in regulated industries. Its operations are mostly focused in North America, with about 20% in EMEA and 10% in APAC. Its clients are predominantly large aerospace and defense vendors and their suppliers.

iBASEt is in the fourth year of major development investment in a microservices-based architecture and a complete revamping of its UI. The initial releases of this capability for shop floor and supervisory roles are complete, and this capability will be extended to its integrated supplier quality and maintenance, repair and overhaul (MRO) capabilities as well.

Strengths

- **Vertical/industry strategy:** iBASEt Solumina has a long, successful track record of providing MES functionality tailored for complex discrete assembly, and is targeted at aerospace, defense, nuclear and other highly regulated industries in discrete manufacturing.
- **Offering (product) strategy:** Unlike most other vendor solutions in this space, iBASEt's aerospace and defense solutions for MES, supplier quality management and MRO were developed organically as part of a suite of capabilities, as opposed to being assembled from purchased applications/vendors.
- **Innovation:** While still incomplete, iBASEt's microservices-based iSeries is available as a cloud solution via Amazon Web Services' (AWS's) Quick Start program. iBASEt plans to market the iSeries product offering on the AWS platform for both SMBs and enterprise clients that wish to digitize smaller sites.

Cautions

- **Market responsiveness/record:** The browser-based UI in iSeries is still very young and might not yet offer the complete set of functional capabilities. Also, the new iSeries UI will not be available across the entire solution for another year or two.
- **Operations:** iBASEt's customer base is predominantly in North America. Companies outside of this region need to ensure that local implementation and support resources are sufficient for their needs.

- **Customer experience:** iBASEt's scores in Ability to Execute were in the lower third of this Magic Quadrant, in part because of slow solution performance, costly hardware requirements and a complex UI on the previous platform. Companies evaluating the new iSeries need to ensure that these problems don't carry over.

iTAC Software

iTAC Software is a Visionary in this Magic Quadrant. The iTAC.MES.Suite is focused on high-volume repetitive flow discrete manufacturing. Its clients tend to be in the automotive and electronics industries. Gartner estimates that iTAC Software's customers are 60% in Europe, 30% in Asia/Pacific and 10% in North America. iTAC Software can run on-premises or in the cloud, but Gartner estimates that more than 90% of its customers use its solution on-premises.

Major developments include a Docker-based workbench to deploy product extensions, a single-tenant provision on AWS and Microsoft Azure, and an HTML5-based UI. A new Quality Management module with enhanced predictive analytics and improved integration to third-party statistical software leverages these concepts.

Strengths

- **Vertical/industry strategy:** iTAC Software has become more fully integrated with its parent company, the Dürr-Group. Enterprise customers in the automotive market (including electronics) can gain advantage through the combined industry expertise and a deeper integration with solutions from the parent company.
- **Innovation:** iTAC Software's architecture roadmap offers a workbench to build stand-alone plug-in modules with data integration, single sign-on and a common UI. This workbench will allow customers and partners to extend the solution and share extensions via a marketplace.
- **Geographic strategy:** iTAC Software's growing presence in global automotive accounts (OEMs and major suppliers) will foster further global expansion and support by major system integration firms. This will help clients with deployments outside of iTAC Software's home market.

Cautions

- **Customer experience:** iTAC Software has some of the lowest scores for project management and support responsiveness. This may be a consequence of iTAC Software and the Dürr-Group focusing too heavily on expansion at existing joint enterprise customers, possibly to the detriment of other clients.
- **Product or service:** iTAC Software scored near the bottom for usability, and customers reported that the user interface needs to be improved. Specific issues were given regarding complicated processes and difficulties with data access. iTAC Software is working to address these topics.
- **Market responsiveness/record:** For the critical data analytics area, iTAC Software is dependent on a third-party solution based on Qlik software. iTAC Software scored near the bottom, and

customers reported dissatisfaction with iTAC Software's built-in data reporting capabilities.

Körber (Werum)

Körber (formerly Werum IT Solutions) is a Leader in this Magic Quadrant. Its Werum PAS-X product is focused on the life science manufacturing vertical – predominantly pharmaceuticals and biotech. Körber's operations are geographically diversified, and its clients tend to be in the large top 100 of the pharmaceutical/biotech industry.

In 2020, Körber unified its brands, including Werum, under a single name. Körber's software product roadmap for life sciences continues to expand on current success in development of microservices and cloud-enabled EBR capability to other areas of the Werum PAS-X product.

Strengths

- **Vertical/industry strategy:** Körber has a strong knowledge of the pharmaceutical business and a product that supports this business, including best-practice library templates for the different pharmaceutical business processes. It received high marks from customers for professionalism, understanding pharmaceutical processes and valuable consulting.
- **Innovation:** Körber has implemented a cloud-enabled electronic batch record capability to a small cell and gene therapy (C>) firm, reinforcing its commitment to more mobile and agile capabilities for the burgeoning C> sector. It has also made use of AI in its Werum PAS-X Chromatography Control, as well as GMP analytics.
- **Overall viability:** The creation of the new Körber Pharma division exposes the Werum PAS-X platform to additional technology and capabilities beyond MES, which will result in a broader set of technology for life science customers.

Cautions

- **Market responsiveness/record:** The PAS-X UI has been changed to HTML5, but the front-end technology (running on the client) is in the process of changing from thick-client to web-based. The back-end technology (running on the server) is in the process of changing from monolithic to containerized architecture (cloud technology). While PAS-X 3.2 will be generally available in 2021, the change to both the front-end and the back-end technologies will be gradual.
- **Operations:** Although Körber has added local certified third-party consultants in various geographies, escalations to senior Körber consultants are described by customers as a constraint. Werum's aspiration of assuming responsibility as primary project partner for customers all over the world can create bottlenecks.
- **Sales execution/pricing:** The life science software experts from Körber are described by customers as being inflexible when it comes to contract negotiations. Körber's score for the "contract and pricing flexibility" category was its lowest score across all Magic Quadrant evaluation criteria.

MPDV

MPDV is a Challenger in this Magic Quadrant. Its HYDRA MES product is broadly used in a variety of manufacturing disciplines across process, batch/repetitive flow and discrete industries. Its operations are mostly focused in EMEA, although it has customers and support in other regions.

MPDV is continuing its work on a web client and on leveraging the joint venture with PerfectPattern – AIMES – for enhanced planning and analytics, and to turn its Manufacturing Integration Platform (MIP) into an app marketplace. It is also intensifying its partner enablement, including some major system integrators (SIs) like Accenture and Cognizant.

Strengths

- **Market responsiveness:** MPDV's expansion of its MIP and acquisition/integration of Felten Group for manufacturing scheduling provide potential clients with more compelling and valuable solutions.
- **Product or service:** MPDV's creation of industry-specific solutions for metals, life sciences, electronics and plastics should be considered by clients in those industries, especially clients in Western Europe. These prepackaged solutions should provide faster time to value and less complicated licensing.
- **Customer experience:** MPDV had one of the highest customer experience scores of all vendors in this research. Customers highlighted the system's modular concept, the overall breadth of functionality and the quality of support.

Cautions

- **Innovation:** MPDV's technology vision scores were in the bottom third of vendors in this Magic Quadrant. Customers should check if MPDV's platform capabilities and architectural roadmap (for example, cloud, no code/low code and user-centric UI) will deliver solutions for their current and future needs.
- **Sales strategy:** Customers are not happy with the complex license structure. This is one downside of MPDV's offering, in which there are a significant number of modules and components. This dissatisfaction was reflected in its overall lower Ability to Execute scores.
- **Geographic strategy:** Despite a growing set of service partners and existing subsidiaries in the U.S., China and Singapore, support for critical implementation and customization issues rely heavily on Germany-based resources, which can create issues for project delivery outside of Western Europe.

Oracle

Oracle is a Challenger in this Magic Quadrant. Its Oracle Manufacturing Cloud (OMC) is an entirely public-cloud-based solution, geared at various discrete as well as repetitive flow/batch manufacturing industries. Oracle's operations are geographically diversified, and its clients tend to use OMC in conjunction with Oracle ERP Cloud.

OMC is updated every three months, with a recent focus on metrics at the factory, machine and work order level. Further enhancements include features like work in progress (WIP) sampling in quality management, out-of-sequence operations, undercompletion tolerance, catch weight handling and deeper integration with IoT.

Strengths

- **Vertical/industry strategy:** Unlike most of the MES vendors in this Magic Quadrant, Oracle chose to create both discrete and process MES in the same data model. Oracle refers to this as mixed-mode manufacturing. It combines discrete, batch and continuous process capability that can be run in the same plant and even in a single work center.
- **Market understanding:** OMC has strong capabilities for managing contract manufacturers in a larger supply chain context, and it was developed internally and refined by actual use in Oracle's manufacturing plants. Management of contract manufacturing continues to be a differentiator for OMC.
- **Product or service:** As a part of Oracle Cloud Applications, it is fairly easy to deploy Oracle Manufacturing Cloud, as it is integrated with other products from Oracle's cloud portfolio.

Cautions

- **Operations:** While Oracle is successfully selling MES to new customers, Gartner estimates that less than half of them went live in production with OMC. Much of this could be attributed to the fact that OMC is implemented after the Oracle Cloud ERP and SCM suites. However, some companies reported a lack of implementation resources and some missing critical functionality as reasons to postpone the deployment.
- **Customer experience:** UI complexity, product performance and responsiveness issues were raised by some customer reviews. Companies evaluating OMC should make certain that it meets their usability and performance requirements.
- **Offering (product) strategy:** Gartner did not see any significant changes in Oracle's MES vision from 2019. Its below-average scores reflect a lack of use cases for advanced capabilities such as artificial intelligence/machine learning (AI/ML) beyond monitoring, KPIs, duration analytics, maintenance and asset management.

Parsec

Parsec is a Leader in this Magic Quadrant. Its TrakSYS product is used across continuous process, repetitive flow/batch and discrete manufacturing. Its operations are geographically diversified, and nearly two-thirds of its customers are in food and beverage, pharmaceuticals, or the CPG industry.

Parsec is continuing to enhance capabilities in visual workflow, production scheduling and inventory management, as well as extending the infrastructure and scheme to enhance higher

availability (uninterrupted operation). From the deployment perspective, Parsec is setting up a project management office to provide support and governance to third-party implementations.

Strengths

- **Geographic strategy:** Although one of the smallest vendors in this Magic Quadrant, Parsec is one of only two vendors in this research that has at least 10% of its customers headquartered in each of the four global regions.
- **Customer experience:** Parsec has the highest percentage of customers with more than five plants in production and the lowest percentage of on-premises implementations, not including the cloud-only vendors. This is due in part to its single-instance/multisite deployment capability.
- **Business model:** Parsec's offering includes MES features and extended MOM features such as APS, warehouse management and analytics – all developed internally by Parsec. Seventy percent of Parsec's deployments are performed by system integrators, with Parsec performing enterprise deployments.

Cautions

- **Marketing execution:** Parsec markets TrakSYS as an out-of-the-box MES. In some functional areas, customers that reviewed TrakSYS and Gartner clients alike reported that the standard out-of-the-box functionality does not offer enough capability.
- **Product or service:** Parsec customer reviewers and Gartner clients expressed a desire for more and better reporting and analysis tools such as a standard product app for overall equipment effectiveness (OEE).
- **Operations:** Parsec had below-average scores for deployment. The most common concern mentioned by Gartner clients is actually too much configurability without enough in the way of governance tools and predefined templates to keep deployments focused.

Plex

Plex Systems (Plex) is a Challenger in this Magic Quadrant. The Plex Smart Manufacturing Platform is a multitenant cloud solution that offers MES stand-alone or as part of a broader ERP solution. It is designed for discrete and batch/process manufacturers, and is strongest in automotive, industrial, precision metal forming, and food and beverage. Its customers are predominantly in North America, with the rest distributed over more than 30 countries supported by offices in Europe and Asia. Most of Plex Systems' customers are midsize businesses that use MES in combination with their smart manufacturing platform or other incumbent ERP providers.

The roadmap includes enhancements for process industries, changes to UX and API support, and improved plant floor integration.

Strengths

- **Product or service:** Plex is the vendor with the longest history of SaaS-based MES and ERP solutions in this Magic Quadrant. It has proven to be able to support hundreds of small and midsize customers with a reliable multitenant MES solution, and has expanded into large enterprises.
- **Sales execution/pricing:** Plex Systems' default price model is based on a customer's total revenue, but it also offers a new "peak-user-based" model. Most customers like Plex Systems' unlimited user price model if they plan to expand the use of further capabilities over time.
- **Offering (product) strategy:** Plex Systems' application architecture offers multiple options to run the entire corporation or individual plants in a layered model. Gartner estimates that approximately 25% of Plex Systems' customers have more than five sites in production.

Cautions

- **Innovation:** The Plex multitenant architecture provides many configuration options, but by its multitenant SaaS nature, the code is identical across the customer base. Clients with high customization requirements beyond the existing configuration parameters should consider other vendors.
- **Vertical/industry strategy:** While customers acknowledge that the system can be tailored using prebuilt templates, they also feel that there are not enough process templates for detailed subindustry capabilities.
- **Customer experience:** Although Plex Systems provides support for implementations, some customers may need to provide significant internal resources (e.g., business analysts) and knowledge to succeed.

Rockwell Automation

Rockwell Automation (Rockwell) is a Challenger in this Magic Quadrant. Its FactoryTalk ProductionCentre product is focused mainly on enterprise customers with high-volume manufacturing, with specific application modules tailored to automotive, consumer products and pharmaceuticals. Rockwell's operations are geographically diversified, and its clients tend to be in discrete, hybrid or batch/repetitive flow process manufacturing.

Rockwell and Microsoft announced a five-year partnership expansion to deliver edge-to-cloud-based solutions. Rockwell bolstered its service capabilities with the acquisition of MES service provider MESTECH Services, followed by the acquisition of Kalypso to increase PTC's ThingWorx expertise related to both MES and IIoT projects.

Strengths

- **Vertical/industry strategy:** Rockwell Automation has upgraded its capability with FactoryTalk InnovationSuite. This improved capability extends MES via innovative dashboards and analytics and, along with the impacts of COVID-19, drove its life science applications to more than 50% of Rockwell Automation's total MES revenue in 2020.

- **Offering (product) strategy:** The Rockwell Automation partnership with PTC has generated additional value in robust MES capability with a state-of-the-market IIoT platform and visualization capability for customers of both companies.
- **Product or service:** Gartner clients and customer reviewers rate Rockwell Automation's forward and backward product genealogy functionality as one of its best features, especially key for regulated industries.

Cautions

- **Customer experience:** Several reviewers and Gartner clients were dissatisfied with the complexity of the current UI. We are concerned that plans to augment the UI with FactoryTalk InnovationSuite (based on ThingWorx) could add complexity and confusion to an already complex solution architecture.
- **Marketing strategy:** Rockwell's technology roadmap is complex and has a lot of moving parts that have caused confusion with customers. Rockwell Automation continues to develop on multiple fronts, both with existing applications and new PTC-based offerings.
- **Market responsiveness/record:** Rockwell Automation received some of the lowest scores in reporting and analytics. Customer references and Gartner clients again reported frustration, including the need to have developers to create reports.

SAP

SAP is a Visionary in this Magic Quadrant. The SAP Manufacturing Suite (Manufacturing Execution, Manufacturing Integration and Intelligence, and Plant Connectivity) supports mostly discrete and hybrid manufacturing. The SAP Manufacturing Suite is used in all major geographies. The largest industry representation comes from high-tech/electronics and general discrete manufacturing, and most deployments are on-premises and supported by SIs.

Key new capabilities include deeper integration to SAP ERP as well as SAP S/4HANA (including Extended Warehouse Management, PEO and other modules), better support for REST APIs, enhancements for quality inspection, and a better handling of configurable products. The work on UX enhancements is ongoing.

Strengths

- **Vertical/industry strategy:** SAP's improved depth of integration between Manufacturing Execution (ME) and S/4HANA makes ME an attractive solution, especially for SAP's large installed ERP base in complex discrete manufacturing industries. This integration provides data consistency and process standardization.
- **Market understanding:** The SAP Manufacturing Suite plays an essential role in SAP's broader Industry 4.0 vision. Companies that wish to leverage all the capabilities may have to look to the Digital Manufacturing portfolio beyond the SAP Manufacturing Suite and be ready for a mix of different deployment modes.

- **Geographic strategy:** The SAP Manufacturing Suite is aligned with the broader SAP technology roadmap, and it is an organic part of its overall business application portfolio. This strategy is in line with its customers' SAP-centric strategy, and is supported by SAP's global presence and partnerships with many major SIs.

Cautions

- **Offering (product) strategy:** SAP's MES portfolio contains two other MES systems, SAP S/4HANA Production Engineering and Operations (PEO) and SAP Digital Manufacturing Cloud, which offer attractive complements to the manufacturing suite for discrete manufacturing. Both products are fairly new and did not qualify for inclusion in this Magic Quadrant. There are few examples where these various MES solutions coexist in a customer deployment.
- **Product or service:** Customers and Gartner clients have reported issues with usability, navigation and visualization. As SAP continues to improve the SAP ME user interfaces, customers should make certain that SAP ME meets usability requirements for their manufacturing environment.
- **Customer experience:** There have been performance issues raised by some customers. Companies should ensure that their technology infrastructure is sufficient to get the performance and throughput required for production use.

Siemens Digital Industries Software

Siemens Digital Industries Software (Siemens) is a Leader in this Magic Quadrant. Its Opcenter Execution products are broadly applied across multiple manufacturing disciplines. Its operations are geographically diversified, and nearly two-thirds of its clients tend to be in electronics/semiconductors, life sciences, food and beverage, and general discrete/repetitive flow/batch manufacturing industries.

Siemens continues to invest across the Opcenter portfolio in UX harmonization, cloud, data analytics and closed-loop functionality. It is also continuing to simplify implementation and postimplementation support across the portfolio, including modular MOM with flexible deployment options.

Strengths

- **Offering (product) strategy:** Opcenter Execution provides MES capability across multiple discrete, process and hybrid industries, with extended MOM features including advanced planning and scheduling; quality management; research, development and laboratory; and manufacturing intelligence.
- **Customer experience:** Siemens' users gave the user interface, system flexibility and system stability high marks in customer reviews. The Siemens Opcenter scored near the top in overall customer experience, which measures both market performance and overall customer satisfaction.

- **Innovation:** Siemens' strategy of data-driven manufacturing has taken its first concrete steps with the cloud-based Opcenter Intelligence for data analytics built with MindSphere and Mendix.

Cautions

- **Product or service:** The Opcenter MOM portfolio includes two MES applications – Opcenter Execution Core (formerly Camstar Enterprise Platform) and Opcenter Execution Foundation (formerly SIMATIC IT Unified Architecture), as well as separate scheduling, quality and R&D applications. Siemens strategy is to provide integrations per industry tailored to reduce implementation and support complexity. Customers must be aware of what industry suite capabilities are currently available and integrated, and which are still under construction, before proceeding with an MES project.
- **Operations:** Gartner sees recurring concerns on the speed and availability of implementation and support resources. This includes difficulties locating expertise for specific requirements or issues. This resulted in Siemens having a below-average score in this category.
- **Sales execution/pricing:** Siemens scored in the bottom third in pricing and contract flexibility, as evidenced by comments from Gartner clients and customer reviewers.

Tulip

Tulip Interfaces (Tulip) is a Challenger in this Magic Quadrant. Its platform, when used in MES applications, is focused mainly on general discrete, chemicals, life sciences and various other industries. Its operations are primarily in North America and in EMEA. Its clients are midsize to large enterprises, and they mostly use the product in public cloud and hybrid environments.

Apart from community-driven enhancements throughout the platform, Tulip's investments are targeted toward device connectivity, biometric user authentication, better support for mobile devices, event-based reactions of apps to incoming machine data, and more global use. The platform is updated in nonregulated industries every two weeks and in regulated ones every six months.

Strengths

- **Innovation:** Tulip's no-code, cloud-based platform is an enabler for MES applications. It is designed to support industrial operations and allows industrial engineers to customize and extend without IT involvement. Its flexibility and ease of use reduce customization, deployment, maintenance costs, risk and complexity.
- **Product or service:** Tulip uses a different approach to integrate with production equipment based on a growing library of edge devices and OPC/UA connectors that reduces the effort for system integration. Tulip Interfaces ships its own edge devices, or can work with supported third-party gateways.

- **Customer experience:** Tulip's platform is extensively using the apps paradigm. Apps are role- and task-specific and can be built by Tulip customers, as well as Tulip partners, and can be shared using a central app library, in addition to existing apps and templates.

Cautions

- **Offering (product) strategy:** Tulip's lower-than-average Completeness of Vision rating reflects that creation and implementation of MES-specific processes are largely left up to the customer. The library offers starting points, but the platform's flexibility requires governance and discipline to ensure application conformity and repeatable processes to prevent individuals building their own personal no-code MES.
- **Geographic strategy:** Tulip's customer base is almost exclusively in North America and Western Europe, and only 15% of its implementations are supported by regional partners.
- **Market understanding:** In life science manufacturing, such as medical devices, pharmaceutical and biotech, Gartner recommends customers to get a headstart on Good Manufacturing Practice (GMP) compliance using Tulip Interfaces' recent capabilities.

Vendors Added and Dropped

We review and adjust our inclusion criteria for Magic Quadrants as markets change. As a result of these adjustments, the mix of vendors in any Magic Quadrant may change over time. A vendor's appearance in a Magic Quadrant one year and not the next does not necessarily indicate that we have changed our opinion of that vendor. It may be a reflection of a change in the market and, therefore, changed evaluation criteria, or of a change of focus by that vendor.

Added

This Magic Quadrant saw the return of ABB Ability, as well as the addition of three newcomers: Critical Manufacturing, iBASEt and Tulip.

Dropped

Vendors dropped from this Magic Quadrant include FORCAM and Sepasoft because these vendors did not meet our enterprise solution inclusion criterion.

Inclusion and Exclusion Criteria

In 2020, we saw a shift in quantity of client inquiries and a shift in focus for MES. There is more concern about innovation at scale. MES is truly an enterprise application, and proven ability to implement more than a handful of sites has become a decision factor for manufacturers that in the past, have seen these implementations stall after only a few sites. To that end, we have added one new inclusion criterion this year (see "Enterprise" below).

To be included in this Magic Quadrant, a vendor must have an enterprise MES solution that fundamentally supports all core MES capabilities and at least some extended capabilities. The

vendor must also exhibit a vision for next-generation MES in at least moderately complex manufacturing environments. Vendors must meet the following criteria for inclusion:

- **Independent:** MES software is regularly sold and used independently of other software and services offered by the vendor (megasuite ERP vendors are excluded from this requirement).
- **Global:** The vendor must have at least 20% of MES customer sites outside its home geographic region (North America, Latin America, EMEA and Asia/Pacific). This does not apply to cloud-only vendors.
- **Enterprise:** At least 10% of customers use the MES software in five or more sites.
- **Customer Base:** At least 25 customers (names, not sites) are in production and actively using the MES software.
- **Growth/Financial Health:** Vendors must meet one of the following three scenarios for new customers, revenue growth and total revenue for their MES:
 - **Scenario 1:**
 - At least 15 net new name (new logo) MES customers (not sites) during calendar year 2019
 - Annual recognized MES software, consulting, implementation service and maintenance revenue in 2019 (calendar or fiscal year) equal to or greater than \$5 million
 - Four-year CAGR of recognized MES software, consulting, implementation service and maintenance revenue for the period 2016 through 2019 equal to or greater than 13%
 - **Scenario 2:**
 - At least 10 net new name (new logo) MES customers (not sites) during calendar year 2019
 - Annual recognized MES software, consulting, implementation service and maintenance revenue in 2019 (calendar or fiscal year) equal to or greater than \$50 million
 - Four-year CAGR of recognized MES software, consulting, implementation service and maintenance revenue for the period 2016 through 2019 equal to or greater than 6.5%
 - **Scenario 3:**
 - At least five net new name (new logo) MES customers (not sites) during calendar year 2019
 - Annual recognized MES software, consulting, implementation service and maintenance revenue in 2019 (calendar or fiscal year) equal to or greater than \$100 million

Honorable Mentions

A number of vendors with capable MES offerings did not qualify for this Magic Quadrant. This does not mean that their solutions might not be viable alternatives for some customers. We limit participation in this Magic Quadrant to vendors that demonstrate current strengths in the market in several dimensions. These include market momentum, geographical coverage, product breadth and depth, and (where appropriate) compelling strength in a specific vertical industry. The Honorable Mentions vendors are as follows.

42Q: 42Q missed qualifying for this research based on the current size of its customer base and the number of new name customers added in 2019.

42Q was the first example of a pure-play multitenant cloud-only stand-alone MES. Originally created as an internal system for Sanmina, a global manufacturing service company, 42Q has been implemented in discrete manufacturing environments that are build to order, configure to order and build to stock across a range of industries. As a SaaS/cloud solution, it offers a flexible pay-by-use subscription model and rapid deployment compared with traditional on-premises MES systems. 42Q is also providing MES capability to Nokia's "conscious factory" (factory in a box) program. The factory-in-a-box concept, or what Gartner refers to as the "mobile factory," reflects the market trend of exploring innovative future factory concepts to support localized, agile production. These factories can be packed into a container or trailer, transported and put into service at a fraction of the time and cost of conventional factories (see [Supply Chain Brief: 'Factory in a Box' Concept Challenges Traditional Factory Setup](#)).

Aegis: Aegis did not qualify for this Magic Quadrant based on Gartner's growth and revenue metrics. Aegis is included in this section as it has one of the only MES systems built on an IIoT platform and because of its new automate-to-order functionality that enhances its existing configure-to-order capability.

Aegis was founded in 1996 and supports more than 2,000 customers, including 600 with end-to-end MES, from its headquarters in Horsham, Pennsylvania, U.S., and with offices in Germany, the U.K. and China. Aegis began with an initial focus in electronics manufacturing. Its MES platform, FactoryLogix, is able to store a product's mechanical and electronic CAD data. All manufacturing information is mapped to this intelligent design data, providing shop floor visual aids, quality data collection, analytics and traceability. FactoryLogix also has a large library of connectors to the machine layer of the factory. The solution provides built-in, user-configurable dashboards, reports and analytics without requiring IT resources. FactoryLogix continues to build on its single codebase, which has been applied to discrete manufacturing process PLC-controlled generic conveyor product flow, through electronics, up to large-scale cell-based manufacturing. The capabilities include process design/product engineering (or NPI), materials logistics, production (for example, shop floor documentation, execution, and quality and control), reporting and analytics. Aegis has been very successful in proliferating an industry standard, IPC International's Connected Factory Exchange (IPC-CFX), which was developed for machine/equipment connectivity. Aegis has clients in several discrete vertical industries, moving beyond its traditional base of assembly of electronic products and components.

Applied Materials: Applied Materials did not qualify for this Magic Quadrant based on the number of new named customers added in 2019. Admittedly, it supports an industry where it is more common to see relatively few, but very large, new customer projects in a typical year.

Applied Materials is headquartered in Santa Clara, California, U.S. Its MES and factory productivity and equipment productivity applications are part of its Applied SmartFactory control and productivity suite, supplying manufacturing solutions in semiconductor (wafer and packaging), flat-panel display (FPD), solar and pharmaceutical. The Applied SmartFactory portfolio of solutions addresses the following manufacturing disciplines: product quality, factory productivity, equipment productivity and supply chain execution. These include out-of-the-box MES solutions for semiconductor and discrete manufacturing, and FACTORYworks-based solutions with factory-specific working templates for semiconductor, packaging and medical device manufacturing. Applied Materials provides capabilities to increase manufacturing effectiveness in the areas of dispatching, scheduling, planning, materials handling, fault detection, statistical process control (SPC), advanced process control, maintenance management, policy automation and factory simulation. Its technology platforms (APF, E3, FACTORYworks, CLASS MCS 5 and FAB300) run high-volume factories, predominantly in the semiconductor industry (nearly 90% of the company's installed base).

L2L: L2L (formerly known as Leading2Lean) missed qualifying for this research based on its position in the market as a lean execution system that supports, but does not necessarily replace, MES. L2L is included here as it provides many key MES functions with an innovative platform.

L2L is based in Sparks, Nevada, U.S. It offers a cloud-based lean execution system that leverages real-time visualized data and tools to engage and motivate human capital at all levels to own and drive problem solving. The offering, CloudDISPATCH, is the core process platform with add-on modules for the disciplines of production, maintenance, inspection, track/trace and integration. The end result is a system that provides information collected in real time, supported by low-code/no-code application development, to empower plant workers to make informed decisions as events occur in the manufacturing process. While most of L2L's application technologies are found in EAM, QMS and MES systems, this may be the first that combines these capabilities in the cloud. CloudDISPATCH also uses lean manufacturing principles to drive process improvement, throughput, equipment availability and quality.

Lighthouse Systems: Lighthouse Systems did not qualify for this Magic Quadrant based on Gartner's growth and revenue metrics. It is included in this section as it has been at or near the top in customer satisfaction scores over the four years of this research.

Lighthouse Systems, based in Crawley, U.K., produces an MES product called Shopfloor-Online that is applicable across a wide range of manufacturing industries. The majority of its customers are in consumer products and repetitive flow manufacturing, such as discrete parts suppliers. The vendor also has a presence in discrete assembly markets. Shopfloor-Online offers a wide set of modules across production, quality, inventory/logistics and maintenance operations, all of which sit atop the core database. The MES software works across all browsers and devices. The solution can be hosted on-premises, in the corporate data center and in the cloud.

Packaging/CPG is the strongest vertical industry in terms of numbers of international multisite operations. Shopfloor-Online is best suited for high-speed manufacturing, including machine events for downtime/OEE/waste, and for meeting quality/inventory control and traceability requirements for high-volume/low-margin production operations such as can-making factories. Its global strategy is via development of a global presence through wholly owned subsidiaries (offices), or through system integrators in strategic geographies or markets.

PSI Metals: PSI Metals did not qualify for this Magic Quadrant based on the number of new named customers added in 2019. As with Applied Materials, it supports an industry where it is more common to see relatively few, but very large, new customer projects in a typical year.

Headquartered in Düsseldorf, Germany, PSI Metals exclusively serves the metals (aluminum, steel and copper) industry, where maximizing asset utilization and shortening lead and delivery times – paired with higher product complexity – are ongoing needs. It offers its production management system solutions based on its product suite, PSImetals, which includes functionality for supply chain planning and scheduling, order dressing, production, and quality execution, as well as inbound and outbound logistics. The product approach enables fully integrated solutions, as well as specialized stand-alone services.

PSI Metals has a standard interface to the SAP ERP system, and it provides the communication adapters of its enterprise application integration (EAI) framework, PSIntegration, to all major ERP and automation providers. In 2020, it launched a new service platform, a first step toward a collaborative enterprise platform in the field of production management. PSI Metals performs on-site implementations, and has a contract with Primetals Technologies that is both a sales and implementation partnership.

Evaluation Criteria

Ability to Execute

Customer service, global reach and operations play strong roles in evaluating the ability of vendors to effectively serve their customers. Gartner finds that customers consider a vendor's ability to provide the services and support necessary to effectively implement the MES as critically important in their ability to achieve the goals of the implementation. Because of this, operations become a key differentiator between providers, as evidenced by Peer Insights reviews. Because MES impacts (and disrupts) production, the lifeblood of any manufacturer, the performance of the vendor (and its partners) in implementing the systems effectively is critical. MES vendors historically provided the majority of implementation services, but most vendors are developing an ecosystem of implementation partners that can supplement or replace the vendor's service capabilities. Furthermore, although companies are buying MES applications, they are also investing in a long-term relationship with their implementation partner (vendor or third party), which increases the importance of operations. Add to this the importance of a global manufacturing network and now, more than ever, MES must be planned, implemented and supported as an enterprise system, not simply a plant-level operations system. Consequently, even though the breadth and depth of the MES product remain important, customer service,

global reach and operations have nearly an equivalent impact on a vendor's overall Ability to Execute.

Product or Service: MES vendors' product breadth, depth and technology are highly rated components of their Ability to Execute. The MES market is unique in that different areas of functionality are more important in some vertical industries than others, but there are key functionalities that define MES and would be expected to be available across the industry landscape. We evaluate the MES products across a range of criteria, including technology and functionality. We consider the depth and flexibility of core capabilities such as procedural enforcement, order execution, data collection, data visibility, quality, tracking, dispatching and reporting/analytics. We also consider the existing breadth of the application's extended MES (aka MOM) capabilities, such as detailed scheduling, definition (BOM/recipe/specification) management and resource management. Users with the most complex requirements and sophisticated operations are the most interested in a vendor's support for extended MES capabilities, which remains a differentiating factor across various systems. Less sophisticated or less complex users are most focused on core MES capabilities and might require less functional breadth. Thus, they could be supported by a wide variety of solutions. The adoption of device-agnostic UI technologies (e.g., HTML5) is expected, and, somewhat surprisingly, there are still vendors reviewed that cannot claim 100% compliance in this area. Finally, since MES has long been heavily customized, we place importance on the technical architectures of each MES. In particular, we note a solution's ability to adapt to change during the initial implementation, as well as over the life of the investment. Therefore, product or service is weighted "high" in this research.

Overall Viability: The viability issue in the MES space, especially when considering the size of vendors covered in the Magic Quadrant, is different than it might be in other spaces. Almost all of the vendors covered in this research are offering MES solutions they acquired from somewhere else. The viability considerations in this market lean more toward the viability of a solution within the context of the parent company's market strategy, rather than the viability of the company itself. Although viability is important, it should not overshadow product fit, vendor expertise, total cost of ownership (TCO), and service and support. We are often asked about the viability of the MES market; however, we cover this in other sections of this research. While important, overall viability is also considered in the inclusion criteria and is not viewed as one of the most important topics. It is weighted "medium" in this research.

Sales Execution/Pricing: Sales execution and pricing are becoming critical factors and, therefore, differentiators in the MES market, especially as MES vendors begin to adopt subscription pricing models. License pricing in the MES market varies widely across deals, depending on size. It seems, to a large degree, arbitrary and based on the specific circumstances of an individual initiative. Price uncertainty has been exacerbated with the growth in cloud-based MES, where subscription-based pricing models dominate. The combination of subscriptions (which have a finite beginning and end) and MES (which rapidly becomes a requirement for keeping a plant running) is perilous. As subscriptions take hold, the ability of vendors to provide open and equitable arrangements for contract renewal becomes paramount. Therefore, sales execution/pricing is weighted "high" in this research.

Market Responsiveness/Record: The MES market continues to evolve rapidly, and MES solutions must keep pace to remain relevant. This makes market responsiveness and track record meaningful. We assess the historical and current performance of vendors to add to and enhance their MES solutions to keep up with the changing wants and needs of MES users. As such, we give market responsiveness/record a “medium” weighting.

Marketing Execution: Although marketing promotion is important, we focus more on a vendor’s product marketing and product management. We look at the product management team, processes and product roadmap to support ongoing innovation, track record of delivering on plans and ability of the vendor to respond to market forces. As such, we give marketing execution a “low” weighting.

Customer Experience: An MES vendor’s ability to use and exploit functionality to drive business value and provide a suitable customer experience is a critical element of a provider’s Ability to Execute. We consider a vendor’s track record with complex and sophisticated customers, but also its ability to effectively and efficiently service less demanding customers. Also critical is client satisfaction with a vendor’s products as well as services, how much manufacturing operations domain expertise and experience the vendor has, and how it can employ this to help customers fully exploit their MES investments. Although client satisfaction is always important, we also consider the nature of the relationship that vendors establish with customers, and whether the relationship is operational or strategic. The size and growth of a vendor’s client bases locally and internationally are also very important because they demonstrate the vendor’s ability to identify and satisfy the needs of customers around the world. Thus, we give customer experience a “high” weighting.

Operations: Operational competence is a very important criterion. It considers a vendor’s ability to meet its goals, obligations and commitments on an ongoing basis. There are marked differences in capabilities across vendors, as confirmed by customer references. Vendor support, maintenance, business and technical consulting, implementation partnerships, and field operations are important parts of the MES selection process. Factors include the quality of the organizational structure, as well as skills, experience, programs, systems and other vehicles that enable an organization to operate effectively and efficiently on an ongoing basis. As projects become more complex, a vendor’s ability to not only sell and implement a solution, but also help customers fully exploit their MES investments, is critical to long-term success. Finally, a vendor’s management structure, experience, skill and expertise play a significant role in a vendor’s ability to harmonize its vision, strategy, tactics and actions. Because of these, we give operations a “high” weighting.

Table 1: Ability to Execute Evaluation Criteria

Evaluation Criteria ↓	Weighting ↓
Product or Service	High

Evaluation Criteria ↓	Weighting ↓
Overall Viability	Medium
Sales Execution/Pricing	High
Market Responsiveness/Record	Medium
Marketing Execution	Low
Customer Experience	High
Operations	High

Source: Gartner (March 2021)

Completeness of Vision

Although the MES market is mature, it is undergoing considerable changes related to the technology, adaptability, usability, breadth of functionality and enhanced decision-support capabilities. The changes embodied in these market shifts, driven by factors such as the IIoT, digital twin/digital thread and governmental vision (e.g., Industrie 4.0), will require considerable nimbleness and competency on the part of vendors. Therefore, in the Magic Quadrant, we place strong emphasis on a vendor's understanding of these market dynamics and its product strategies to support those offerings. Exhibiting and articulating a vision for where MES will be in the future, and exhibiting an innovative culture, remain distinguishing characteristics among vendors.

MES is just one component in what should be an integrated set of capabilities connecting manufacturing to the extended supply chain. Vendors are also evaluated on how well they understand the emerging concept of supply chain collaboration, and what strategies they have to move in this direction. While having an MES vision is notable, a vendor's vision for broader supply chain convergence is critical to moving farther to the right side of the Magic Quadrant, and this differentiates offerings. Because supply chain collaboration is an emerging best practice, we also consider vendor strategies to support this concept beyond basic data or transaction integration.

All qualifying solutions in this Magic Quadrant handle basic core MES. Another distinguishing characteristic of vendors moving to the right will be the breadth of extended MES capability, sometimes referred to as MOM capability. This includes the vendor's current and planned support for the MES innovation capabilities like detailed scheduling, definition (BOM/recipe/specification) management and resource management.

Vendors' domain expertise, technology vision and vision for the MES of the future rank highly. We consider vendors' knowledge and vision for manufacturing execution and, more broadly, the manufacturing supply chain locally and internationally. We also consider a vendor's vision for MES, not simply process execution, which means demonstrating a compelling vision for how manufacturing, business and technology trends will influence MES in the future.

Market Understanding: A demonstrated knowledge, proficiency and differentiated vision of the current and future MES marketplace are critical considerations. Market understanding assesses the MES vendor's ability to understand MES buyers' wants and needs for the manufacturing modes they cover and translate them into products and services. Vendors that show the highest degree of vision listen to, anticipate and understand buyers' wants and needs, and can augment customer insight with their own MES visions. Vendors that simply respond to current market requirements without anticipating future requirements will likely be unsuccessful over the long term. Marketing understanding is also considered in the inclusion criteria; consequently, we give market understanding a "medium" weighting.

Marketing Strategy and Sales Strategy: Until recently, marketing strategy and sales strategy have had modest impacts on the MES market, which had historically been dominated by specialist vendors focused on specific vertical industries. Today, marketing and sales strategies are becoming more important, particularly as enterprise vendors become MES providers. However, we consider vendors' strategies for establishing their MES brand – and how they develop strategies and tactics for local and international expansion – to be of less importance than other factors. Therefore, we give these two criteria, marketing strategy and sales strategy, a "low" weighting.

Offering (Product) Strategy: This criterion is critical; it refers to an MES provider's approach to product marketing, research and development, and solution delivery that emphasizes differentiation. We consider strategies for functionality, usability, technology, adaptability, delivery methodologies and feature sets as they map to current and future MES requirements, market trends and technology evolutions for the manufacturing modes they cover. In addition, we consider vendors' strategies for supporting end-to-end processes that span functional areas such as order management, materials management, definition management and analytics. A vendor's understanding of these market changes and its product strategies for successfully navigating these changes significantly influence its Completeness of Vision. Therefore, offering (product) strategy gets a "high" weighting.

Business Model: A vendor's business model (i.e., the soundness and logic of its underlying business propositions) is a key indicator of its sustainability and how its overall strategies and tactics might affect its ongoing success in MES. For example, one vendor might focus on organic innovation, while another might concentrate on buying innovation through mergers and acquisitions. While the former might have a longer gestation period, it has potential product and technical advantages. The latter might allow a vendor to get to market faster but could cause longer-term product issues. We give business model a "medium" weighting.

Vertical/Industry Strategy: In MES, a vendor’s vertical/industry strategy is a key factor in how well the offering is aligned to specific industry requirements. Vertical/industry strategies are critical, so we give this criterion a “high” weighting. A vertical/industry strategy may be a vendor’s commitment to mastery of a few key vertical industries or relying on an ecosystem of partners to fill in the gaps between its solution and the industry-specific solution that the customer desires. Both are viable approaches, but the vendor must have a well-designed strategy to be successful in what has been a very fragmented market.

Innovation: Innovation is a critical differentiator. It is important for vendors to demonstrate the ability to support innovation by staying close to the most creative solutions or complicated problems in the market to drive pioneering functionality. Innovation is a critically important factor in the MES industry, even though manufacturing production has been conservative in the adoption of new technologies in the past. Innovation and thought leadership continue to play a strong role in this year’s evaluations. Leading vendors continue to enhance core MES with more investment in extended MES. Gartner continues to evaluate innovations in these practices. However, this year, we are placing a strong influence on the technology side. Leaders are expected to embrace technology innovations that enable cloud, platform/infrastructure as a service, low-code/no-code application development and the composable enterprise. Leaders and Visionaries will be the vendors on the forefront of change, while others will lag in adoption, often for years. Consequently, we give innovation a “high” weighting.

Geographic Strategy: This research is focused on the global MES marketplace. Geographic strategy looks at technology providers’ strategies for directing resources, skills and offerings to meet the specific needs of global manufacturing. At this stage in the evolution of the MES market, there is more interest in global enterprise-level solutions. We give geographic strategy a “medium” weighting.

Table 2: Completeness of Vision Evaluation Criteria

Evaluation Criteria ↓	Weighting ↓
Market Understanding	Medium
Marketing Strategy	Low
Sales Strategy	Low
Offering (Product) Strategy	High
Business Model	Medium
Vertical/Industry Strategy	High

Evaluation Criteria ↓	Weighting ↓
Innovation	High
Geographic Strategy	Medium

Source: Gartner (March 2021)

Quadrant Descriptions

Leaders

Leaders combine the uppermost characteristics of vision and thought leadership with a strong Ability to Execute. Leaders in the MES market are present in a high percentage of new MES deals, and they win a significant number of them. They have robust core MES and offer reasonable – although not always leading-edge – capabilities in extended MES/MOM areas. To be a Leader, a vendor doesn't necessarily need to have the absolute broadest or deepest MES application. Its offerings must meet most core MES requirements without significant modifications, and a substantial number of high-quality implementations must be available to validate this. Leaders must anticipate where customer demands, markets and technology are moving, and must have strategies to support these emerging requirements ahead of actual customer demand. Leading vendors should have coherent strategies to support supply chain convergence, and must invest in and have processes to exploit innovation. Leaders also have market momentum and strong client satisfaction – in the vendor's local markets as well as internationally. Client satisfaction starts with the initial sales engagement and continues through deployment and beyond. Leaders understand the importance of customer satisfaction and approach customer issues as trusted partners. Because Leaders are often well-established in leading-edge and complex user environments, they benefit from a user community that helps them remain in the forefront of emerging needs.

Key characteristics:

- Reasonably broad and deep MES offerings
- Proven success in moderate- to high-complexity manufacturing environments
- Participation in a high percentage of new deals
- A strong and consistent track record
- Consistent performance and vigorous client growth and retention
- Enduring visibility in the marketplace from both sales and marketing perspectives

- A proven ecosystem of partners
- Global scale

The 2021 Leaders quadrant includes a mix of enterprise and pure-play vendors. That fact and the increase from six to seven leaders show a maturing of the MES market, though admittedly we expect disruption ahead as some established leaders start to lag behind.

Challengers

While vendors in this quadrant provide solid and established MES solutions, they generally have one or more insufficiencies in offerings or go-to-market strategies when compared with Leaders. The critical characteristic of Challengers is that they have capable, proven and mature products, with numerous live customers. They also have consistent track records of successful implementations. Challengers' offerings often run some very large and complex facilities. These solutions are in use by a large number of individual enterprises supporting multiple manufacturing operations locally and worldwide. These solutions are preferred by buyers that favor Ability to Execute over Completeness of Vision. Vendors can have practical visions for these solutions and, more generally, supply chain execution, but vision and thought leadership typically are not as complete as with vendors in the Leaders quadrant.

Vendors in the Challengers quadrant are mature, functionally solid and proven, with strong track records of customer adoption and successful deployments. Their solutions typically have strong core capabilities and some extended MES capabilities. Although offerings in the Challengers quadrant are normally functionally robust, the vendor or specific MES solution either is not at the forefront of innovation or may be weaker in certain capabilities.

Key characteristics:

- A capable, proven and mature MES, with numerous live customers
- A consistent track record of successful implementation
- Often running some large and complex facilities
- Offerings that are not as broad or deep as MES Leaders' offerings
- A clear vision of the future of MES, although, relatively speaking, it is not as clear or complete as the Leaders' vision

Visionaries

Visionaries must have a coherent, compelling and innovative strategy that seeks to deliver a robust and vibrant offering to the market. However, these offerings have some deficiencies in their Ability to Execute in areas such as viability, growth, global scale or operations. Visionaries are often thought leaders in one or more MES solution dimensions (e.g., analytics, model-based process development, vertical industry or deployment strategies), and they tend to be on the

leading edge of some emerging concepts. At a minimum, solutions in the Visionaries quadrant fall into one of two broad categories. They can be vendors with established MES offerings that have yet to mature into leading positions in the market, or they can be innovative specialist vendors with unique and potentially disruptive views of where the market is going. These vendors can exhibit innovation in MES products, services, or go-to-market and deployment strategies, but lack innovation in other areas.

The Visionaries quadrant is populated with vendors solidifying their positions as thought leaders while looking to improve their Ability to Execute. Many of them exhibit innovative solutions, deployment models or go-to-market strategies. Vendors in this quadrant, although innovative and offering intriguing solutions, have yet to solidify their long-term viability and global positions.

Key characteristics:

- A coherent, compelling and innovative strategy that seeks to deliver a robust and vibrant offering to the market
- A thought leader in one or more MES solution dimensions that tends to be on the leading edge of emerging concepts
- An undemonstrated ability to handle a broad range of complex user requirements
- Execution gaps or deficiencies
- Innovation in MES products and services, and in go-to-market, vertical or deployment strategies

Niche Players

Although there might be an assumption that vendors in the other quadrants are better choices for new MES buyers, Niche Players are often just as good or sometimes better choices for prospective users. This is because they might focus on a geographic or vertical component of the market that is meaningful to particular users. However, this focus alone is not a compelling-enough differentiator for a vendor to ascend to a leadership position. It would also have to perform well in other dimensions. Although some vendors in the Niche Players quadrant often have solid MES solutions for a specific industry or geography, they are not as broad as the MES solutions in other quadrants.

Key characteristics:

- Focuses primarily on a geography or vertical market (although this is not a sole determining factor)
- Is not a generally differentiated offering, although it can have some unique capabilities
- Is not a broad MES capability
- Has market momentum and product or company viability that may be in question

- Has growth strategies, either geographic or in other markets, that may be lacking

Context

The MES market is highly fragmented by vertical industry, technology, manufacturing processes/style and application functionality, which makes choosing a vendor difficult.

Vendors with leading market shares continue to extend the functional footprint of their MES offerings farther into extended MES (MOM) via internal development and acquisition. Newcomers tend to provide more organically developed solutions built on state-of-the-art platforms, but may not offer broad functionality.

Given the market's fragmentation, when selecting an MES vendor, it is important to consider:

- Business or process opportunity prompting this selection and whether it requires full MES, extended MOM or possibly a subset of that functionality that may be available in specialized applications not identified as MES/MOM
- Demonstrable understanding of your industry and modes of manufacturing (backed up by multiple independent customer references)
- Integration maturity of the platform and experience in integration with all of the related business and production systems (ERP, planning and scheduling, WMS, QMS, PLM, production equipment)
- SLAs and quality-of-service requirements
- Security and regulatory compliance needs
- The geographic location of the support centers
- The ability to deploy the MES platform as a solution in a mode that suits your enterprise architecture (single-instance/multisite, public cloud, private cloud, corporate data centers or on-premises)
- The availability and cost of MES skills from the provider and external service providers
- The long-term cost expectations and available budget
- The short- and long-term product roadmap

Gartner recommends starting the selection process after developing a thorough understanding of your requirements and priorities. Be pragmatic and tactical, and evaluate domain-specific solutions, where appropriate, for quick wins.

Market Overview

There is a fundamental technological shift taking place in the MES market, driven by evolving new technologies that challenge the MES status quo and driven by vendors with the agility and talent to accelerate the adoption of those technologies. We see these trends in the market:

- Vendors are increasing their adoption of platform as a service (PaaS) architectures and low-code/no-code app development; and some are succeeding in the MES market, often to the detriment of the enterprise vendors that have recently dominated this space.
- The pandemic has pushed manufacturers to embrace the agility of cloud-native, availability-anywhere systems. We see that the vendors that have embraced these capabilities and are developing these organically have a significant head start on others that have embraced application growth by acquisition.
- IIoT and edge capabilities continue to mature. As these solutions mature and end-user manufacturers generate new, scalable use cases beyond simply monitoring equipment condition, the distinction between IIoT applications and traditional MES applications will continue to blur.

Continuing from the trends above, we see an acceleration of the transformation of traditional application architectures into “composable” applications. The complete reference architecture is described in [Use Gartner’s Reference Model to Deliver Intelligent Composable Business Applications](#). Composable MES applications are characterized by adopting principles and technologies such as:

- Built out of modular and autonomous packaged business capabilities (PBCs); these can be sourced externally from a vendor or built internally.
- Equipped with a set of stable APIs that can be exposed to different users according to their respective roles.
- Leveraging an application composition platform to support more complex business processes that leverage multiple PBCs.
- Sharing data through an open data fabric, which also consolidates data of multiple applications for integrated analytics, artificial intelligence (AI) and reference access.

An architecture like this has allowed some vendors to offer their clients:

- A low-code/no-code environment that lets citizen developers and business users build personalized capabilities catered to their individual needs with less cost and risk associated with traditional customization.
- An apps marketplace for partners and customers to offer prebuilt extensions, dashboards, additional capabilities and more.

- An HTML5-based, user-centric and role-specific UX that can be personalized and expanded by the user with no involvement of IT or professional developers.

However, it should be noted that simply having this architecture and these features does not mean a vendor is providing an off-the-shelf MES solution. Significant discipline, governance and domain expertise are required to turn these components into a production-worthy, scalable MES.

Incorporating these architecture principles is simpler for vendors with a newly built MES solution. In general, it is fair to assume that the longer a MES system has been in the market, the more effort is needed to fundamentally rearchitect it. For instance, it is fairly easy to surround an entire existing solution with a layer of APIs and interfaces to allow for easier integration with other applications. However, it is much more difficult to modularize the solution and break it into components that can then be reassembled and enhanced according to a customer's needs.

One area where this becomes immediately visible is the UI: "simply porting an existing UI to HTML5 doesn't do the job," as one customer reference pointed out. A complete redesign is needed, resulting in a user-centric UI that is catered to different roles and can be altered by end users. Some vendors with more mature systems have started this transformation, but it will take most of them years to finalize it.

This transformation, once completed, will provide more flexibility and allow for more agility in the deployment, use and enhancement of these solutions. This flexibility and agility have proven to be among the main drivers of resilience that was so visibly important during the COVID-19 crisis.

These trends, disruptors and events have had an impact on the Magic Quadrant results, and we suspect these changes will continue in future publications of this Magic Quadrant.

Finally, when considering the supply chain (plan, source, make, deliver) and supply chain maturity, there is a growing desire to break down the barriers between MOM (make) and the rest of the supply chain from both a process and a technology direction. As the MES/MOM market continues to evolve and change, the ability to remove these artificial barriers will be a key consideration in vendor choice.

Evidence

This research is based on information gathered from the following sources:

- Peer Insights reviews from 269 MES customers
- Online surveys and/or vendor briefings from 38 MES vendors
- More than 750 inquiries on MES/MOM in 2019 and 2020

¹ [ANSI/ISA-95.00.03-2013 Enterprise-Control System Integration – Part 3: Activity Models of Manufacturing Operations Management](#), International Society of Automation (ISA).

Evaluation Criteria Definitions

Ability to Execute

Product/Service: Core goods and services offered by the vendor for the defined market. This includes current product/service capabilities, quality, feature sets, skills and so on, whether offered natively or through OEM agreements/partnerships as defined in the market definition and detailed in the subcriteria.

Overall Viability: Viability includes an assessment of the overall organization's financial health, the financial and practical success of the business unit, and the likelihood that the individual business unit will continue investing in the product, will continue offering the product and will advance the state of the art within the organization's portfolio of products.

Sales Execution/Pricing: The vendor's capabilities in all presales activities and the structure that supports them. This includes deal management, pricing and negotiation, presales support, and the overall effectiveness of the sales channel.

Market Responsiveness/Record: Ability to respond, change direction, be flexible and achieve competitive success as opportunities develop, competitors act, customer needs evolve and market dynamics change. This criterion also considers the vendor's history of responsiveness.

Marketing Execution: The clarity, quality, creativity and efficacy of programs designed to deliver the organization's message to influence the market, promote the brand and business, increase awareness of the products, and establish a positive identification with the product/brand and organization in the minds of buyers. This "mind share" can be driven by a combination of publicity, promotional initiatives, thought leadership, word of mouth and sales activities.

Customer Experience: Relationships, products and services/programs that enable clients to be successful with the products evaluated. Specifically, this includes the ways customers receive technical support or account support. This can also include ancillary tools, customer support programs (and the quality thereof), availability of user groups, service-level agreements and so on.

Operations: The ability of the organization to meet its goals and commitments. Factors include the quality of the organizational structure, including skills, experiences, programs, systems and other vehicles that enable the organization to operate effectively and efficiently on an ongoing basis.

Completeness of Vision

Market Understanding: Ability of the vendor to understand buyers' wants and needs and to translate those into products and services. Vendors that show the highest degree of vision listen to and understand buyers' wants and needs, and can shape or enhance those with their added vision.

Marketing Strategy: A clear, differentiated set of messages consistently communicated throughout the organization and externalized through the website, advertising, customer programs and positioning statements.

Sales Strategy: The strategy for selling products that uses the appropriate network of direct and indirect sales, marketing, service, and communication affiliates that extend the scope and depth of market reach, skills, expertise, technologies, services and the customer base.

Offering (Product) Strategy: The vendor's approach to product development and delivery that emphasizes differentiation, functionality, methodology and feature sets as they map to current and future requirements.

Business Model: The soundness and logic of the vendor's underlying business proposition.

Vertical/Industry Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of individual market segments, including vertical markets.

Innovation: Direct, related, complementary and synergistic layouts of resources, expertise or capital for investment, consolidation, defensive or pre-emptive purposes.

Geographic Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of geographies outside the "home" or native geography, either directly or through partners, channels and subsidiaries as appropriate for that geography and market.

© 2021 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner is a registered trademark of Gartner, Inc. and its affiliates. This publication may not be reproduced or distributed in any form without Gartner's prior written permission. It consists of the opinions of Gartner's research organization, which should not be construed as statements of fact. While the information contained in this publication has been obtained from sources believed to be reliable, Gartner disclaims all warranties as to the accuracy, completeness or adequacy of such information. Although Gartner research may address legal and financial issues, Gartner does not provide legal or investment advice and its research should not be construed or used as such. Your access and use of this publication are governed by [Gartner's Usage Policy](#). Gartner prides itself on its reputation for independence and objectivity. Its research is produced independently by its research organization without input or influence from any third party. For further information, see "[Guiding Principles on Independence and Objectivity](#)."